



## Understanding the role of digital technologies in education: A review

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### ABSTRACT

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. This paper is brief about the need for digital technologies in education and discusses major applications and challenges in education.

### 1. Introduction

Sustainable development includes social well-being, which depends on education. Information technology has emerged to spread shared knowledge and is a primary driving force behind education reforms. The introduction of new technology-assisted learning tools such as mobile devices, smartboards, MOOCs, tablets, laptops, simulations, dynamic visualisations, and virtual laboratories have altered education in schools and institutions. The Internet of Things (IoT) is proven to be one of the most cost-effective methods of educating young brains. It is also a robust mechanism for integrating a world-class learning experience for everybody [1–3]. Educational technology businesses are continually attempting to create novel solutions to expand access to education for individuals who cannot obtain adequate educational facilities. Social media as a learning tool has come a long way. Large numbers of teachers and students use social media as an essential element of the overall e-learning experience. It is a critical venue for exchanging information about crucial topics these days. Aside from the ability to communicate information anywhere, at any time, social media sites are also a fantastic

source of producing networking possibilities to establish social activities and possibly new jobs [4,5].

Traditional classroom instructions fall short of providing an immediate learning environment, faster evaluations, and more engagement. In contrast, digital learning tools and technology fill this void. Some of the efficiencies such technologies provide are simply unrivalled by traditional learning methodologies. With smartphones and other wireless technology devices becoming popular among the general public, it only makes sense that schools and educational institutions make efficient use of them by putting technology in the classroom. Indeed, today's technology's adaptability and non-intrusive character make learning more appealing to the next generation. However, it may be a formidable technique to manage initially since traditional instructors are hesitant to include contemporary technology and gadgets in school, viewing them as a distraction rather than an intelligent learning aid [6,7]. An online classroom calendar, where we may display class schedules, assignment schedules, field excursions, speaker events, examinations schedules, or semester breaks, will help students plan accordingly. Student response systems, such as smartphones and clicker devices, provide a quick and

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easy technique for teachers to determine students' learning of the presented content quickly and whether more explanation is required [8,9].

Digital technologies influence agricultural operations, and they will soon revolutionise how farming is done in developed countries, reducing our dependency on pesticides and substantially cutting water use. COVID-19 Pandemic, lockdown, and quarantine are three concepts that have recently entered our lexicon. People worldwide are aware of the catastrophe caused by the coronavirus epidemic. In this crisis, digital technologies are at least keeping the educational system afloat. Students are learning from the convenience of their own homes [10,11]. Integrating technology into education provides students with an engaging learning experience, allowing them to remain more interested in the subject without being distracted. The utilisation of projectors, computers, and other cutting-edge technical gear in the classroom may make studying fascinating and entertaining for students. Student learning can become more dynamic and engaging by establishing tasks in class that incorporate technology resources, oral presentations, and group participation. Participation can extend beyond verbal communication as well [12–15].

From the environmental impact of using less paper for handouts and books to the time savings and convenience of research, digital learning is a wonderful way to cut costs, better utilise resources, promote sustainability and expand both reach and impact for students and teachers. [16,17]. Technology is pervasive and intertwined in many aspects of modern life and society. The digital revolution that is sweeping the world has begun to infiltrate the realm of education. It is rapidly transforming the way students learn, and as a result, technology is expected to improve the face of education by making it more inexpensive and accessible [18–20]. This paper is brief about the applications of digital technologies in education. The next three sections discuss the need for digital technologies in education and brief about the Digital classrooms and applications of digital technologies in education. It is followed by a section on the challenges of digital technologies in education along with a discussion on the future of digital technologies in education.

### 1.1. Research objectives

The primary research objectives of this paper are as under:

**RO1:** - To study the need for digital technologies in education;

**RO2:** - to brief about the importance of digital classroom in education and identify the role of digital technologies applications in education;

**RO3:** - To identify the significant challenges of digital technologies in education.

## 2. Need for digital technologies in education

The globalisation of education has already necessitated the application of digital technologies. Online platforms were available for conducting classes, sharing resources, doing the assessment and managing the day to day activities of academic institutions. However, the use of these platforms was proactive. The COVID-19 Pandemic has forced the institutes to adopt the online teaching mode to sustain the education system. Developed countries were well equipped to deal with this crisis. However, developing countries worked hard to meet this requirement. Digital technologies have emerged as the saviour of education in this critical time [21–24]. This global crisis highlights the need to be internationally integrated into the education system. Digital technologies assist in developing abilities that will require students' professional performance, such as problem-solving, thinking structure creation, and process comprehension. They are also preparing for a more unpredictable and changing future in which technology will play a critical role. Students' acquired qualities and abilities will be essential to their professional success. Educational resources and digital tools help to improve

the classroom atmosphere and make the teaching-learning process more compelling. Furthermore, they give each educational institution greater flexibility and customisation of curriculum based on the requirements of each student [25–29].

Children might become more engaged in learning if technology is used in the classroom. Because youngsters nowadays are pretty accustomed to the usage of electronic gadgets, incorporating them into schooling would undoubtedly assist in piquing their interest and enhancing their involvement levels. Integrating technology into education provides students with an engaging learning experience, allowing them to remain more interested in the subject without being distracted. The utilisation of projectors, computers, and other cutting-edge technical gear in the classroom may make studying fascinating and entertaining for students. Student learning can become more dynamic and engaging by establishing tasks in class that incorporate technology resources, oral presentations, and group participation. Participation can extend beyond verbal communication as well [30–32].

Using computers and other devices in conjunction with digital tools allows students to play a more proactive role and be at the centre of the process [33–35]. The instructor becomes a guide in this process and can approve learning efficiency. Using the myriad of digital resources, learners may download the required information or upload their content. The web 2.0 technologies (wikis, podcasts, blogs etc.) facilitate learners to generate content, collaborate with others, assess each other work and move toward co-learning. Digital technologies make it easy to use classroom tactics like gamification or approaches like flipped classrooms that optimise learning. Learning landscapes have evolved as a didactic tool that mixes several techniques and enables distinct itineraries to be presented to each student. Technology makes the instruction more inspiring and meaningful [36–38].

## 3. Digital classroom

Digital classrooms are defined by using electronic devices or platforms such as social media, multimedia, and mobile phones to teach students. With digital technology in education, today's educational landscape has altered for the better or improvements. Digital learning is a learning strategy that employs technology to fulfil the entire curriculum and allows students to learn quickly and rapidly [39–41]. The digital classroom entirely focuses on teaching via the use of technology. Students use technological or internet-connected gadgets like laptops, tablets, Chromebooks, etc. Instead of taking notes on what the teacher has taught, most of the curriculum is delivered to students online through an engaging and interactive platform. Despite its many facets, education is fundamentally a kind of communication. The internet has resulted in the rise of new communication channels, which have extended the options for the transmission and access to educational information. These media and virtual venues serve as learning facilitators [42–45]. Various features of a digital classroom are shown in Fig. 1.

Educational applications and websites are used in digital classrooms to assist students in improving their learning experience. Feedback loops and technology are two critical components of a digital classroom. Feedback loops are essential for students to obtain real-time feedback from their teachers. Teachers can use feedback loops to provide feedback depending on many factors such as student, lesson, group, etc. PPTs, video presentations, e-learning methods, online training, and other digital approaches are increasingly used in the teaching-learning process [46–48]. As a result, classroom instruction is becoming more participatory. Students may now learn many topics on their own by using internet resources and digital classrooms. In schools, colour charts, graphs, and models describe the finest instruction of the class. However, they are now considered old-fashioned methods of giving education. Education in the classroom is no longer restricted to reading books, writing on the blackboard to explain chapters and concepts, and taking notes in their books [49–51].

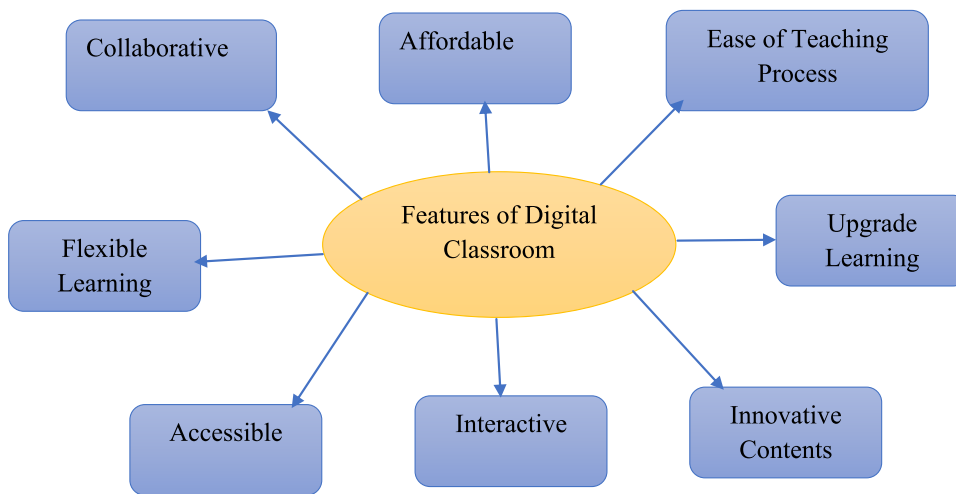


Fig. 1. Features of Digital Classroom.

#### 4. Applications of digital technologies in education

Digital technologies are a powerful instrument that can help improve education in various ways, such as making it easier for instructors to generate instructional materials and providing new methods for people to learn and collaborate. A new era has arrived with the Internet's worldwide reach and many intelligent devices connected to it. Thus, it will be up to instructional designers and educationists to use advanced digital technology's potential to revolutionise education such that effective and efficient education is available to everyone and everywhere [52–54]. Technology has continued to play an essential role in delivering education to children outside the classroom. Digital learning fosters creativity and gives students a sense of success, encouraging additional learning by thinking outside traditional techniques. All nations were able to adopt remote learning technologies utilising a combination of TV, radio, online, and mobile platforms, which is commendable. These provide easy access to information, easy retention of information, increased storage of information, and improved presentation of information; education became more interactive, easier sharing of knowledge and increased enthusiasm in learning [55–57]. Table 1 discusses the significant applications of digital technologies in education.

With today's technological growth, instructors must learn to utilise various gadgets, such as smartphones and tablet computers, or face marginalisation. Teachers must also harness all available online resources to ensure that their materials are alive, engaging, and up to date. Technology is more than just playing video games and viewing animated films. The advantages are determined by how students, parents, and teachers use technology to improve education. When technology is used effectively for instructional reasons, the educational experience improves, and students become interested. Making e-learning systems compatible with new smart devices such as phones and tablets has been a significant element in the ease of access and faster uptake of digital learning. Specialised learning goods, such as animation, games, or AI-powered systems designed exclusively for edutainment, are also included. Technology-enabled innovations have helped facilitate learning across age groups and topics. The importance of Big Data and the application of analytics to learning was an essential but generally overlooked part of Education technologies [208,209]. Schools and educational institutions realise the value of comprehensive student and instructor performance data as they extend their usage of virtual classrooms, e-learning platforms, and online exams.

#### 5. Challenges of digital technologies in education

Educational technology is not without its difficulties, notably in implementation and usage. Issues regarding excessive screen time, the ef-

ficacy of instructors' use of technology, and concerns about technology fairness are also raised. The content has become more significant as a result of the COVID-19 problem. Educators must generate and comment on online educational content, encouraging students to analyse a topic from several angles in particular. Furthermore, while some students thrive in online learning settings, others struggle due to various factors, including a lack of support. For example, a student who has previously suffered in face-to-face circumstances may suffer far more in the current situation. These people may have been reliant on services that are no longer accessible. However, online education may provide difficulties for instructors, particularly in areas where it has not been the norm [210,211,212].

Some of the reasons for the learning crises are widely known. One crucial factor is the poor quality of instruction. Teachers frequently lack topic expertise and have received little training. There are technology solutions to this, and they could be helpful in both training instructors and instructing students. Technologies can provide in-service training or a combination of online and in-person training. Additionally, there is evidence that instructors require better incentives. They can educate but lack the motivation to do so. Even though education has always extended outside the conventional classroom, the changing circumstances and scale of digital and remote contexts demand significant adaptation, preparation, support, and engagement. Limited or no contact with students, rethinking engagement, reaching, teaching approaches, appropriately addressing a range of unique needs, motivating students, handling conflicting time demands, and coping with constrained settings may contribute to attentive learning and teaching. [213,214,215].

There is also evidence that low-tech interventions for "instruction at the appropriate level" can significantly affect learning. Because low-tech solutions are less expensive and funding restricts impoverished nations, careful investigation is required to establish whether high-tech or low-tech solutions are better or not. Teachers are teaching through video, but they are not always teaching better than they would if they were standing in front of a classroom. More massive open online courses are being offered and taken up, but many are not for primary education and do not address the learning issue. It necessitates hardware and connectivity at home, inaccessible to children in low-income homes. Gamification and other strategies may encourage youngsters to devote more time to studying. Finally, consider that effective learning outcomes may be obtained without using education technologies [216,217].

Some students are having difficulties as a result of this online schooling. Some students come from low-income families and do not have cell-phones in their homes; thus, they struggle in school. Millions of youngsters simply do not have access to the internet at home. Students under 15 acquire this complex technology early, yet they struggle with poor vision and backache. Teachers are also having difficulty since some are utterly inexperienced with digital technologies. Nonetheless, they do ev-

**Table 1**  
Digital technologies applications in education.

S. No	Applications	Description	References
1.	Improve teaching productivity	Teaching productivity may be improved by using advanced technological aids, which facilitate better planning, easy and practical learning, quick assessment, better resources, new skills, etc.	[58–62]
2.	Develop Online libraries	Technological advancements have helped create and develop online libraries, which have removed the physical space requirement and facilitated interaction among students, teachers, and researchers from across the globe. Online forums have brought subject specialists to discuss specific topics and evaluate the curriculum, teaching pedagogy, and assessment methods.	[63–66]
3.	Promote Distance learning	In reality, technological advancement has boosted distance learning education. It provides easy access to all learning resources and allows the facility to interact with the instructor conveniently. Teachers may quickly build and manage groups using learning tools and technology such as social learning platforms.	[67–71]
4.	Facilitate Teaching of students with exceptional needs	It is encouraging to see how much assistive technology is available to help students with physical or learning disabilities absorb concepts quickly and actively participate in their classes. Speech recognition, screen-reading tools, Braille displays, and text-to-speech solutions are among the revolutionary technologies for the visually impaired; for the hearing impaired, closed-captioning applications, sound amplifiers, and video conferencing technologies facilitate sign language and lip-reading.	[72–76]
5.	Create Virtual 6.classroom	Digital technologies in education have given rise to various Learning management systems (LMS). These LSMs have promoted virtual classrooms where a teacher can interact with students in real-time, share his resources, deliver his lecture, assess students' learning, collect feedback, and reply to their queries.	[77–80]
6.	Build knowledge and understanding skills	Technologies strive to build knowledge, understanding, and skills to ensure that students thrive individually and as a team. Teachers may encourage children's curiosity and inquisitiveness through exciting and instructive material, which has been linked to their academic performance.	[81–84]
7.	Creating Inclusive learning environments	An inclusive learning environment provides an equal opportunity for each student with different ability levels to learn in the same place. Virtual classrooms, video, augmented reality, robots, and other technology tools make the class exciting and create inclusive learning environments that foster collaboration and curiosity while allowing teachers to collect data on student performance.	[85–89]
8.	Developing teamwork and communication skills	Teamwork and communication skills are two crucial attributes that help develop a successful professional. Digital technologies play an essential role in developing these skills.	[90–93]
9.	Solving educational challenges	Students collaborate to solve ongoing educational challenges using online platforms. Hackathons have emerged as a successful event to find the solutions to many challenging problems. Students may express themselves and collaborate on activities by sharing their thoughts and ideas.	[94–97]
10.	Enhanced access to educational resources	Access to educational resources anytime is now possible, seven days a week. Cloud storage, video recording of lectures and availability of notes in a soft copy made it easy for students to access the resources at their convenience. Even parents can access these resources and check the quality of lectures and notes.	[98–102]
11.	Addressing students to completing the syllabus	Computer-assisted learning is the most direct way to support students by helping the teachers complete the syllabus. Students have different baseline learning levels in a classroom, and teachers are frequently driven to teach to the highest stratum, leaving many students behind. These technologies have helped such students in completing their syllabus.	[103–106]
12.	Transformed the innovative way of learning	Digital technology has transformed the way pupils learn in the classroom, even though the education industry has evolved. Students are taught digital skills and encouraged to bring computers to class so that they may access a variety of materials quickly. Students are encouraged to explore information in new and exciting ways through educational applications and programmes. Teachers can use interactive whiteboards and classroom clickers to introduce and reinforce topic knowledge while changing their teaching approaches. Reporting and assignment management have changed substantially rather than generating real report cards to send home once a term. Instructors may now assign, collect, and grade work using specialised learning management systems, keeping students and parents informed about their progress.	[107–110]
13.	Arithmetic classes	Digital tools help students listen to math classes and respond by typing, scribbling, or dictating their remarks. As the school year progresses and the years pass, digital technology will be employed to make math education through practice more accessible to all students, regardless of ability or learning environment. These technologies also give pupils the option of studying or demonstrating their math skills in various ways. Because the learning environment is more dynamic than it has ever been, today's students are very different from those for whom the educational system was created. As technology improves, classrooms are being remodelled and reimagined in numerous ways to meet the increasing expectations of modern digital learners.	[111–115]
14.	Convenient teaching and learning	COVID-19 has heightened the role of technology in the lives of billions of students around the world. Regardless, digital technology is the only way for the educational institution to thrive in this challenging day. Internet-based learning resources are now widely available. Furthermore, the AI system has significantly enhanced learning. Intelligence can identify a student's strengths and weaknesses on its own. They have a customised learning strategy to ensure that each student reaches their full potential. At times, they can even be more rewarding than classroom education. Coronavirus has shaken the entire planet, and people are progressively acclimating. As a result of the Pandemic, office staff are working from home. This situation affects everyone, and underprivileged people find it challenging to go about their daily lives. On the other hand, students can continue their education at home by employing digital technologies.	[116–119]
15.	Reduce the requirement for a blackboard	The class with the most advanced technologies is now considered the best class. The use of technology in city schools has grown significantly in recent years. Blackboards have been replaced with PowerPoint presentations, online courses, and videos. Today, all schools incorporate technology into their curriculum in some form. Several schools have digitised their whole education system by recognising the function of digital classes in school. Because of the advancement of the internet, mobile phones, mobile apps, tablets, laptops, and other gadgets, more and more aspects of today's world are becoming digital. Digital education is replacing conventional education in classrooms in many schools and colleges.	[120–124]
16.	Making classroom instructions interesting	Classroom instruction has become more exciting and participatory due to digital education. Children are becoming increasingly aware of it. They not only listen to what the teacher says, but they also watch it on the screen. It facilitates visual learning for youngsters. The instructional material in practical sessions in digital classrooms lets students pay greater attention to details through interactive online presentations. Students now have more options and control over their learning experiences because of technology in the classroom. Learning technologies have also provided academics with greater freedom in offering lectures or labs. Students can tune in to live-streamed lectures at a given time, whilst others can watch lecture recordings independently if they cannot attend a live session. Furthermore, real-time courses in online learning may provide students with better interests.	[125–129]

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Table 1 (continued)

S. No	Applications	Description	References
17.	Built curriculum and support materials	Using modern technology, each teacher may build their curriculum and support materials, employing their most creative side to personalise learning. Although many people favour traditional teaching methods, the possibilities are endless when technology is integrated into the classroom. Education has become much more accessible, with a wide choice of learning techniques and degree options available. Teachers should think about why students want to use technology in the classroom rather than need it. It will surely assist educators in tracking student progress and developing innovative lesson strategies. Students who learn using technology can build skills that will help them succeed in the future.	[130–134]
18.	Improve students' performance	Educational technology improves student performance by systematically approaching instructional procedures and resources. It recognises individual needs by incorporating technology into classroom instruction and tracking student progress. Instructors must appropriately expose conditions to select appropriate technology for the curriculum delivery and track outcomes to determine the success of the measures. Teachers can use the information offered by online activities to figure out which students suffered in particular classes and provide additional aid and support. Students can ask questions about the classroom and receive extra help with the challenging subject matter.	[135–139]
19.	Flexible education	As a result of technology improvements, education is becoming more flexible and accessible. Online degrees and mobile learning are becoming more popular, physical boundaries have been removed, and technologies can help their employees pursue their education. These are an excellent way for teachers to teach children how to keep organised and simplify their tasks right from the start. In addition to giving children access to information, modern technology has the potential to excite and empower them.	[140–144]
20.	Students gain self-learning abilities.	Students can build self-directed strong learning abilities by using learning tools and technology. They can figure out what they need to know, locate and use online resources, apply what they have learned to the problem, and even analyse comments. As a consequence, they have increased their production and efficiency. Digital learning tools and technology engage students and improve critical thinking skills, the foundation for developing analytic reasoning. Because they require children to observe the rules and conventions to play, interactive social skill games effectively teach youngsters discipline. Even children dissatisfied with other learning methods may continue to play games for a long time since playing itself is enjoyable. This aids in developing patience, which is another essential life skill. Children experience feelings of accomplishment due to gaining new knowledge and skills through digital learning tools, which gives them the confidence to pursue new interests.	[145–149]
21.	Expand knowledge	Students who use digital learning tools and technology are more involved and want to learn more. They may not even realise they are actively learning because they are learning through exciting approaches such as peer education, teamwork, problem-solving, reverse teaching, concept mapping, gamification, staging, role-playing, and storytelling. Because it is substantially more engaging and remembered than big textbooks or one-sided lectures, digital learning delivers a deeper context, a broader viewpoint, and more stimulating activities than traditional teaching strategies. As a result, students can better connect with the learning information. Furthermore, they frequently provide a more exciting and engaging approach to processing information.	[150–155]
22.	Addresses learning gaps	By addressing learning gaps early and enhancing growth, each student's capacity to personalise learning sequences will make education more successful. In addition to educators, parents may use interactive activities to increase their child's interest in learning since gamification makes the process more enjoyable and engaging. Parents can use internet learning activities to augment their children's schoolwork. Digital learning tools and technology provide youngsters with fun and a plethora of benefits for their overall development. Digital learning allows students to access more knowledge and ensures that the content is customisable and tailored to their specific requirements. The ability to assist each student in studying at their speed and on their route is the most crucial advantage of digital learning.	[156–159]
23.	Quickly gain information	Educators may quickly exchange information with other educators using digital learning tools and technologies in real-time. The growth of free and open content and tools has produced a sharing economic atmosphere. Classrooms worldwide may collaborate to share ideas and improve learning, experience, and communication skills by adopting digital devices and linked education. These also provide instructors with a fair playing field. Schools may save money while ensuring that all students have equitable access to educational materials. Problem-based learning is emphasised in digital learning solutions and constructive, collaborative learning techniques that direct students' attention to a real-world approach to learning. In elementary, secondary, and high schools, digital learning tools and technology support students in developing problem-solving skills, understanding emerging technologies, and self-motivation, which prepare them for future education and work.	[160–165]
24.	E-books	Students can now discover information more quickly and correctly with advances in technology. Search engines and e-books are replacing traditional textbooks. On the other hand, students may begin to learn how to be responsible in the digital world by introducing technology into the classroom. The class becomes a microcosm of the larger digital environment in which students may practise communicating, searching, and interacting with other digital citizens. Technology has also increased communication and cooperation opportunities. Classrooms have traditionally been isolated, with cooperation confined to other students in the same classroom or building. Today's technology provides types of communication and collaboration previously unimaginable. Kids can share their knowledge with students in other schools around the country.	[166–171]
25.	MOOC Platform	Students benefit from MOOCs to improve their credentials and talents. It enables millions of learners who cannot afford an education to enhance their employability by giving them access to various skill-based courses. Thanks to MOOCs, students and working professionals can study at their speed, from anywhere and at any time. Furthermore, some lecture courses offered through this platform result in a certificate that institutes and enterprises recognise as a step in the right direction. According to recent trends, online classes delivered through the MOOC platform have a sizable market. Students enrolled in professional studies and working executives are more motivated to improve their skill set to take advantage of growing job opportunities in specialised industries. MOOC-based personalised learning is becoming more popular.	[172–176]
26.	Video-based instructional learning	Technologies based blended learning with entertainment and video-based instructional education is prevalent among students. This type of teaching-learning medium is highly participatory. This form of teaching style comprises not only audio-video but also instructional applications, podcasts, eBooks, and so on. Children are ecstatic to discover new concepts through these digital platforms. With the internet becoming more economical and accessible, there will be a more significant confluence of digital and conventional teaching-learning methods in the future. Online education provides freely available material for learning, teaching, and research. It enables students to engage with a wide range of study material publicly available on the internet, therefore establishing a self-learning environment.	[177–180]

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Table 1 (continued)

S. No	Applications	Description	References
27.	Increased educational opportunities	The effective use of technology will undoubtedly increase educational opportunities. Students now have access to a wide range of online resources and journals linked to their study themes via their computers and portable devices, allowing them to obtain additional information for their schoolwork. Furthermore, digital platforms provide students with reliable and high-quality data from their PC, anywhere and anytime. Aside from information resources, technology in education allows students to contact academic professionals worldwide. Technology in education is the most significant revolution in teaching that will ever witness.	[181–184]
28.	Access teaching up-to-date material	Thanks to recent technological developments, students may now access the most up-to-date teaching. The traditional passive learning paradigm has been challenged, and due to technological advancements, educators can directly involve students in more effective learning methods.	[185–187]
29.	Breakdown all educational barriers	Technology breaks down all educational barriers, allowing students and instructors to communicate in real-time and learn in ways that transcend time and location. Indeed, technology-based classrooms provide students with a unique environment to learn complicated subjects straightforwardly. A complete and rigorous learning experience would add a new dimension to their learning and assist them in achieving academic success. Technology integration starts in elementary school and progresses to high school and higher education.	[188–190]
30.	Offer environmental benefits	Using technology in the classroom offers environmental benefits as well. Institutions can save money on ink and paper by storing vital documents in a single digital place. There is lesser transportation of students and more secondary emissions, but there is no substitute for physical interactions between students and teachers.	[191–193]
31.	Dynamic learning	Teachers can use technology to create a more dynamic and exciting learning environment. Technology also provides a dynamic classroom environment by digitising textbooks and incorporating links and QR codes to study and assess course subjects. Technologically adept teachers may profit from the advent of new technologies. Software for specialised activities or the establishment of flipped classrooms, for example, is employed. In this scenario, students can watch pre-recorded lectures as homework and arrive at class ready to discuss topics and information. New digital instruments in classrooms necessitate management and training. Teachers must be productive in the classroom and online, using a variety of screens and technological platforms. The internet and other digital technologies, according to teachers, have greatly expanded the number of topics and abilities they must be knowledgeable about, and over half believe their workload has grown as a result.	[194–197]
32.	Reduce teacher workload	New technologies are introduced by automating repetitive procedures and elements of the educational process. There are tools available for developing and grading exams. Most will post the findings to a database, where each student's performance may be easily verified. It takes time to communicate with students and their families. Teachers may use social media and texting to reach out to the entire community and engage in one-on-one conversations with each student and parent. These facilitate online spreadsheets, social network account updating, and contact information organisation.	[198–201]
33.	Assessing students in real-time	Digital technology can revolutionise students' learning experiences in and out of the classroom. Technology allows us new ways of interacting, building knowledge, assessing students in real-time and preparing students for life in an increasingly digital world. Opportunities exist for instructors to reinvent instructional techniques, learn, and work more efficiently to improve wellness. Appropriate technology in an educational environment thus is evaluated for its ability to satisfy educational goals.	[202–204]
34.	Moving to Hybrid teaching & learning	Hybrid Teaching and learning involve the supplementary and complimentary use of Online and Offline teaching and learning. This is the future and an outcome of Education 4.0.	[205–207]

everything possible to educate their children through online classes. College students who take more practical subjects than theoretical subjects face similar challenges because practical knowledge is not attainable in online programmes [218,219].

While technology can be considered yet another avenue for cheating, it is possible to design assignments and assessments so that such an occurrence is unlikely. On the other hand, open-book exams can be used to emphasise problem-solving and mastery over retention. Time-consuming processes such as tracking student attendance and performance can be sped up with automation. Because of their objective nature, engagement tools can assist in expediting grading for writing assignments, conversations, and participation and address typical student inquiries. Without proper information and communication technology equipment, internet/mobile network connectivity, instructional resources, and teacher training, students cannot participate in distant education. Students from resource-poor locations, isolated rural areas, and low-income households are more likely to fall behind. Learners with disabilities or who speak a language other than English at home will require additional individualised assistance.

## 6. Discussion

Digital technologies allow students to experience the globe and go to faraway places from the comfort of their computers. Inviting a guest speaker to talk to the class about their expertise is terrific to spice up any lesson plan. Video conferencing systems make it simple to bring a subject matter expert face-to-face to our classroom, no matter where they are. We can easily organise a classroom video conference with kids from an-

other institution. Online polls and other digital technologies engage all students, timid kids who would not ordinarily raise their hands in class. Online engagement tools enable checking in with students regularly to solicit input on course materials and assignments. Student insights can also be utilised to identify areas where students may be struggling. Student response systems promote digital citizenship in the classroom by allowing students to participate in class while also being rewarded. Schools serve an essential role in our communities, and their closure has far-reaching consequences for the psychological well-being of many families and children. Digital technologies can easily take up this challenge. Online learning allows students to learn at their speed, pause and rewatch videos, and explore course content independently.

Quizzes are another active learning strategy that education technology may help. Students may begin working on a project together in class and fluidly collaborate, communicate, and bounce ideas off one another utilising social media, interactive whiteboards, and other technology. Physical and social constraints allow students to collaborate from anywhere and at any time. Technology has also enabled students to join in spontaneous discussions and obtain immediate answers to any difficulties or questions regarding a subject. Because of self-paced learning and individual variances, students will virtually always complete their work at various times. When this happens, maintaining students' attention is as simple as giving them access to educational films, course-based games, or interactive learning tools. As a result, faster-paced students no longer need to wait for all of their colleagues to finish before continuing their studies, while slower-paced students are no longer tempted to rush through their work. This Education 4.0 programme will be implemented in future schools to improve education and better prepare the next gen-

eration of potential. Further, Artificial intelligence will help driverless cars travel more effectively and reduce emissions. Material scientists are using AI to produce biodegradable plastic substitutes and techniques to clean our seas. Recycling and upcycling may appear to be simple procedures, yet they are highly effective instruments for increasing sustainability efforts. Recycling is a game-changer for sustainability, whether it is consumers reusing bottles to decrease plastic waste or businesses fashioning discarded objects into new goods.

## 7. Future of technologies in education

Small, medium and large-scale education technology companies have started proliferating in the future and are offering various new digital solutions to academic institutions. This will improve the quality of digital infrastructure across the country, making innovative educational technology more accessible to larger masses. We foresee the removal of all linguistic boundaries and better Online availability of learning resources in regional languages. E-learning and m-learning programmes provide students and teachers access to a vast pool of information content. While technology will play an essential role in shaping the future of education, ensuring that new teaching tools are used effectively will require a new generation of educators who understand the importance of human connection in the classroom. These can lead to a satisfying and engaging career in education. Students gain the knowledge and skills necessary to employ new educational technology to maximise their advantages for today and in the future. In upcoming years, education trends will ride the tide of growing internet capabilities and network capacity, making it easier to incorporate innovative technology into classrooms. However, there is no complete substitute for offline (classroom) teaching & learning. Thus we have reached the era of hybrid teaching and learning, where both online and offline systems are integrated to enhance the outcomes and are envisaged as an outcome of the implementation of Education 4.0

## 8. Conclusion

Digital technology in the classroom refers to various software and gadgets meant to help students with particular accessibility needs. The most effective way to reduce the number of repetitive, time-consuming duties a teacher undertake is to use technology in the classroom. Educational technology applications may save a lot of time and energy by automating or partially automating day-to-day operations like attendance tracking and performance monitoring. Students are taught how to use technology responsibly and strategically, which can help them make decisions and develop self-discipline. Technology in education can help students to prepare for lifelong learning. These technologies provide students with a virtual world and the freedom to access digital knowledge according to their learning styles. Thanks to digital content production tools that customise teaching and learning, students can study at their own pace. The digital classroom uses electronic devices and software to instruct students and incorporates technology into education. A traditional classroom is transformed into a digital classroom through computers and the Internet. Students can learn more efficiently and track their progress with the help of technology and sophisticated equipment. In the upcoming days, these technologies will successfully be implemented in education to enhance the students' digital learning environment and performance. Modern technologies have been instrumental in complicated data analysis and management to make long-term decisions in areas such as climate change, air and water security, biodiversity protection, catastrophe resilience, etc. These technologies refer to innovation that considers natural resources while also promoting economic and social growth. These aim to dramatically decrease environmental and ecological concerns while producing a long-term product. These technologies reduce degradation, pollution, and other negative environmental effects.

## Declaration of Competing Interest

None.

## References

- [1] J. Keengwe, M. Bhargava, Mobile learning and integration of mobile technologies in education, *Education and Information Technologies* 19 (4) (2014) 737–746.
- [2] S. Dreimane, R. Upenieks, Intersection of serious games and learning motivation for medical education: A literature review, in: *Research Anthology on Developments in Gamification and Game-Based Learning*, 2022, pp. 1938–1947.
- [3] P.L. Rogers, Barriers to adopting emerging technologies in education, *Journal of educational computing research* 22 (4) (2000) 455–472.
- [4] Haddad, W. D., & Draxler, A. (2002). The dynamics of technologies for education. *Technologies for education potentials, parameters, and prospects*, 1, 2-17.
- [5] C.I. Büyükbaykal, Communication technologies and education in the information age, *Procedia-Social and Behavioral Sciences* 174 (2015) 636–640.
- [6] T.A. Vakaliuk, O.M. Spirin, N.M. Lobanchykova, L.A. Martseva, I.V. Novitska, V.V. Kontsedailo, Features of distance learning of cloud technologies for the quarantine organisation's educational process, *J. Phys. Conf. Ser.* 1840 (1) (2021, March) 012051.
- [7] B. Cavas, P. Cavas, B. Karaoglan, T. Kisla, A Study on Science Teachers' Attitudes Toward Information and Communications Technologies in Education, *Online Submission* 8 (2) (2009).
- [8] I.O. Biletska, A.F. Paladieva, H.D. Avchinnikova, Y.Y. Kazak, The use of modern technologies by foreign language teachers: developing digital skills, *Linguistics and Culture Review* 5 (S2) (2021) 16–27.
- [9] S.H. Kim, K. Holmes, C. Mims, Opening a dialogue on the new technologies in education, *TechTrends* 49 (3) (2005).
- [10] G. Emmanuel, A. Sife, Challenges of managing information and communication technologies for education: Experiences from Sokoine National Agricultural Library, *International journal of education and development using ICT* 4 (3) (2008).
- [11] G. Kostopoulos, S. Kotsiantis, Exploiting semi-supervised learning in the education field: A critical survey, in: *Advances in Machine Learning/Deep Learning-Based Technologies*, 2022, pp. 79–94.
- [12] S. Akbaba-Altun, Complexity of integrating computer technologies into education in Turkey, *Journal of Educational Technology & Society* 9 (1) (2006) 176–187.
- [13] F. Mikre, The roles of information communication technologies in education: Review article with emphasis to the computer and internet, *Ethiopian Journal of Education and Sciences* 6 (2) (2011) 109–126.
- [14] E. Bilotta, F. Bertacchini, L. Gabriele, S. Giglio, P.S. Pantano, T. Romita, Industry 4.0 technologies in tourism education: Nurturing students to think with technology, *Journal of Hospitality, Leisure, Sport & Tourism Education* 29 (2021) 100275.
- [15] H. Perraton, Choosing technologies for education, *Journal of educational media* 25 (1) (2000) 31–38.
- [16] M.A. Camilleri, A.C. Camilleri, Digital learning resources and ubiquitous technologies in education, *Technology, Knowledge and Learning* 22 (1) (2017) 65–82.
- [17] M. Beardsley, L. Albó, P. Aragón, D. Hernández-Leo, Emergency education effects on teacher abilities and motivation to use digital technologies, *British Journal of Educational Technology* (2021).
- [18] A.J. Cañas, J.W. Coffey, M.J. Carnot, P. Feltoovich, R.R. Hoffman, J. Feltoovich, J.D. Novak, A summary of literature pertaining to the use of concept mapping techniques and technologies for education and performance support, Report to the Chief of Naval Education and Training (2003) 1–108.
- [19] M.I. Qureshi, N. Khan, H. Raza, A. Imran, F. Ismail, Digital Technologies in Education 4.0. Does it Enhance the Effectiveness of Learning? *International Journal of Interactive Mobile Technologies* 15 (4) (2021).
- [20] K. Yordanova, Mobile learning and integration of advanced technologies in education, in: *Proceedings of the 2007 international conference on Computer systems and technologies*, 2007, June, pp. 1–6.
- [21] M. Javaid, A. Haleem, R. Vaishya, S. Bahl, R. Suman, A. Vaish, Industry 4.0 technologies and their applications in fighting COVID-19 pandemic, *Diabetes & Metabolic Syndrome: Clinical Research & Reviews* 14 (4) (2020) 419–422.
- [22] J. Seale, C. Colwell, T. Coughlan, T. Heiman, D. Kaspi-Tsahor, D. Olenik-Shemesh, 'Dreaming in colour': disabled higher education students' perspectives on improving design practices that would enable them to benefit from their use of technologies, *Education and Information Technologies* 26 (2) (2021) 1687–1719.
- [23] S. Burlacu, Characteristics of knowledge-based economy and new technologies in education, *Revista» Administratie si Management Public «(RAMP)* (16) (2011) 114–119.
- [24] A.C.D. Araújo, J. Knijnik, A.P. Ovens, How do physical education and health respond to the growing influence in media and digital technologies? An analysis of curriculum in Brazil, Australia and New Zealand, *Journal of Curriculum Studies* 53 (4) (2021) 563–577.
- [25] C. Dufour, C. Andrade, J. Bélanger, Real-time simulation technologies in education: a link to modern engineering methods and practices, in: *Proc. 11th Int. Conf. on Engineering and Technology Edu*, 2010, March, pp. 7–10. *INTERTECH 2010*.
- [26] V.L. Dudar, V.V. Riznyk, V.V. Kotsur, S.S. Pechenizka, O.A. Kovtun, Use of modern technologies and digital tools in the context of distance and mixed learning, *Linguistics and Culture Review* 5 (S2) (2021) 733–750.
- [27] J.B. Lagrange, M. Artigue, C. Laborde, L. Trouche, A meta-study on IC technologies in education. Towards a multidimensional framework to tackle their integration, in: *PME CONFERENCE*, 1, 2001, July, pp. 1–111.

- [28] B. Somekh, Taking the sociological imagination to school: An analysis of the (lack of) impact of information and communication technologies on education systems, *Technology, pedagogy and Education* 13 (2) (2004) 163–179.
- [29] S. Kosaretsky, S. Zair-Bek, Y. Kersha, R. Zvyagintsev, General education in Russia during COVID-19: Readiness, policy response, and lessons learned, in: *Primary and Secondary Education During Covid-19*, Springer, Cham, 2022, pp. 227–261.
- [30] B.E. Penprase, The fourth industrial revolution and higher education, *Higher education in the era of the fourth industrial revolution* 10 (2018) 978–981.
- [31] Kryukov, V., & Gorin, A. (2017). Digital technologies as education innovation at universities. *Australian Educational Computing*, 32(1), 1-16.
- [32] O. Lopez-Fernandez, Emerging Health and Education Issues related to Internet Technologies and addictive problems, *Int. J. Environ. Res. Public Health* 18 (1) (2021) 321.
- [33] Halverson, R., & Shapiro, R. B. (2012). Technologies for education and technologies for learners: How information technologies are (and should be) changing schools. *Wisconsin Center for Educational Research (WCER), Working Paper*, 6.
- [34] P.T. Kovács, N. Murray, G. Rozinaj, Y. Sulema, R. Rybárová, Application of immersive technologies for education: State of the art, in: 2015 International Conference on Interactive Mobile Communication Technologies and Learning (IMCL), IEEE, 2015, November, pp. 283–288.
- [35] V.V. Osadchyi, N.V. Valko, L.V. Kuzmich, Using augmented reality technologies for STEM education organisation, *J. Phys. Conf. Ser.* (1) (2021, March1840) 012027.
- [36] A.C. Borthwick, C.L. Anderson, E.S. Finsness, T.S. Foulger, Special article personal wearable technologies in education: Value or villain? *Journal of Digital Learning in Teacher Education* 31 (3) (2015) 85–92.
- [37] S. Desai, Role of information communication technologies in education, in: *Proceedings of the 4th National Conference*, 6, 2010, pp. 109–126.
- [38] A. Kumar, R. Agrawal, V.A. Wankhede, M. Sharma, E. Mulat-Weldemeskel, A framework for assessing social acceptability of industry 4.0 technologies for the development of digital manufacturing, *Technological Forecasting and Social Change* 174 (2022) 121217.
- [39] R. Oliver, Ten more years of educational technologies in education: how far have we travelled? *Australian Educational Computing* 20 (1) (2005) 18–23.
- [40] E. Pacheco, M. Lips, P. Yoong, Transition 2.0: Digital technologies, higher education, and vision impairment, *The Internet and Higher Education* 37 (2018) 1–10.
- [41] Y.E. Turgut, A. Aslan, Factors affecting ICT integration in TURKISH education: A systematic review, *Education and Information Technologies* (2021) 1–24.
- [42] J. Roschelle, M. Sharples, T.W. Chan, Introduction to the special issue on wireless and mobile technologies in education, *Journal of computer-assisted learning* 21 (3) (2005) 159–161.
- [43] S. Grek, From symbols to numbers: the shifting technologies of education governance in Europe, *European educational research journal* 7 (2) (2008) 208–218.
- [44] S. Villagrasa, D. Fonseca, E. Redondo, J. Duran, Teaching case of gamification and visual technologies for education, *Journal of Cases on Information Technology (JCIT)* 16 (4) (2014) 38–57.
- [45] D.N. Nguyen, B. Zierler, H.Q. Nguyen, A survey of nursing faculty needs for training in the use of new technologies for education and practice, *J. Nurs. Educ.* 50 (4) (2011) 181–189.
- [46] F. Ozdamli, N. Cavus, Knowledge sharing technologies in higher education: Preferences of CIS students in Cyprus, *Education and Information Technologies* 26 (2) (2021) 1833–1846.
- [47] G. Vavoula, M. Sharples, P. Lonsdale, P. Rudman, J. Meek, Learning Bridges: a role for mobile technologies in education, *Educational Technology* (2007) 33–37.
- [48] E. Lacka, T.C. Wong, M.Y. Haddoud, Exploring the role of Virtual Learning Environment and Social Media use in Higher Education, *Computers & Education* 163 (2021) 104099.
- [49] H.L. Schnackenberg, Tablet technologies and education, *International Journal of Education and Practice* 1 (4) (2013) 44–50.
- [50] R. Gurunath, D. Samanta, A novel approach for semantic web application in online education based on steganography, *International Journal of Web-Based Learning and Teaching Technologies (IJWLTT)* 17 (4) (2022) 1–13.
- [51] B. Collis, Information technologies for education and training, in: *Handbook on information technologies for education and training*, Springer, Berlin, Heidelberg, 2002, pp. 1–20.
- [52] V. Varea, G. González-Calvo, A. García-Monge, Exploring the changes of physical education in the age of Covid-19, *Physical Education and Sport Pedagogy* 27 (1) (2022) 32–42.
- [53] L. Lockyer, J. Patterson, Integrating social networking technologies in education: a case study of a formal learning environment, in: 2008 eighth IEEE international conference on advanced learning technologies, IEEE, 2008, July, pp. 529–533.
- [54] R.N. Carvalho, C.E.F. Monteiro, M.N.P. Martins, Challenges for university teacher education in Brazil posed by the Alpha Generation, in: *Research in Education and Learning Innovation Archives*, 2022, pp. 61–76.
- [55] J. Hsu, Innovative technologies for education and learning: Education and knowledge-oriented applications of blogs, wikis, podcasts, and more, *International Journal of Information and Communication Technology Education (IJICTE)* 3 (3) (2007) 70–89.
- [56] R. Grainger, Q. Liu, S. Geertshuis, Learning technologies: A medium for the transformation of medical education? *Med. Educ.* 55 (1) (2021) 23–29.
- [57] E. Lacka, T.C. Wong, Examining the impact of digital technologies on students' higher education outcomes: the case of the virtual learning environment and social media, *Studies in Higher Education* 46 (8) (2021) 1621–1634.
- [58] A. Stone, J. Briggs, C. Smith, SMS and interactivity-some results from the field, and its implications on effective uses of mobile technologies in education, in: *Proceedings. IEEE International Workshop on Wireless and Mobile Technologies in Education*, IEEE, 2002, August, pp. 147–151.
- [59] C. Schelly, G. Anzalone, B. Wijnen, J.M. Pearce, Open-source 3-D printing technologies for education: Bringing additive manufacturing to the classroom, *Journal of Visual Languages & Computing* 28 (2015) 226–237.
- [60] T. Jevsikova, G. Stupuriene, D. Stumbrienė, A. Juškevičienė, V. Dagienė, Acceptance of distance learning technologies by teachers: determining factors and emergency state influence, *Informatica* 32 (3) (2021) 517–542.
- [61] P. Carmichael, K. Jordan, Semantic web technologies for education-time for a 'turn to practice'? *Technology, Pedagogy and Education* 21 (2) (2012) 153–169.
- [62] A.A. Abdullayev, System of information and communication technologies in the education, *Science and world International scientific journal* 2 (2020) 19–21.
- [63] B. Marks, J. Thomas, Adoption of virtual reality technology in higher education: An evaluation of five teaching semesters in a purpose-designed laboratory, in: *Education and information technologies*, 2021, pp. 1–19.
- [64] Evans, T., & Nation, D. (2013). 12 Educational Technologies: reforming open and distance education. *Reforming open and distance education: Critical reflections from practice*, 196.
- [65] L.M. Nkomo, B.K. Daniel, R.J. Butson, Synthesis of student engagement with digital technologies: a systematic review of the literature, *International Journal of Educational Technology in Higher Education* 18 (1) (2021) 1–26.
- [66] Y. Beldarrain, Distance education trends: Integrating new technologies to foster student interaction and collaboration, *Distance education* 27 (2) (2006) 139–153.
- [67] M.A. Camilleri, A.C. Camilleri, The acceptance of learning management systems and video conferencing technologies: Lessons learned from COVID-19, *Technology, Knowledge and Learning* (2021) 1–23.
- [68] J. Sandars, S. Schroter, Web 2.0 technologies for undergraduate and postgraduate medical education: an online survey, *Postgrad. Med. J.* 83 (986) (2007) 759–762.
- [69] V. Arkorful, N. Abaidoo, The role of e-learning, advantages and disadvantages of its adoption in higher education, *International Journal of Instructional Technology and Distance Learning* 12 (1) (2015) 29–42.
- [70] J. Zhang, A cultural look at information and communication technologies in Eastern education, *Educational Technology Research and Development* 55 (3) (2007) 301–314.
- [71] A. Tiili, J. Zhang, Z. Papamitsiou, S. Manske, R. Huang, H.U. Hoppe, Towards utilising emerging technologies to address the challenges of using Open Educational Resources: a vision of the future, *Educational Technology Research and Development* 69 (2) (2021) 515–532.
- [72] N.A. Kudratilloev, B.A. Akhmedov, Application of communication-cluster technologies in pedagogical institutions: interactive methods of processing graphic data, in: *Scientific Progress*, 2021, p. 1.
- [73] D.J. Skiba, H.R. Connors, P.R. Jeffries, Information technologies and the transformation of nursing education, *Nurs. Outlook* 56 (5) (2008) 225–230.
- [74] B. Collis, I. Jung, Uses of information and communication technologies in teacher education, in: *Teacher education through open and distance learning*, 2004, pp. 187–208. Routledge.
- [75] K.F. Hew, W.S. Cheung, Use of Web 2.0 technologies in K-12 and higher education: The search for evidence-based practice, *Educational research review* 9 (2013) 47–64.
- [76] Carlson, S., & Gadio, C. T. (2002). Teacher professional development in the use of technology. *Technologies for education*, 118-132.
- [77] E.Y. Barakina, A.V. Popova, S.S. Gorokhova, A.S. Voskovskaya, Digital Technologies and Artificial Intelligence Technologies in Education, *European Journal of Contemporary Education* 10 (2) (2021) 285–296.
- [78] R. Mason, Learning technologies for adult continuing education, *Studies in Continuing Education* 28 (2) (2006) 121–133.
- [79] U. Murod, B. Suvankulov, M. Bakiyeva, D. Nusratova, Fundamentals of Creation and Use of Interactive Electronic Courses on the Basis of Multimedia Technologies, *Annals of the Romanian Society for Cell Biology* (2021) 6860–6865.
- [80] D. Kellner, New technologies/new literacies: Reconstructing education for the new millennium, *Teaching Education* 11 (3) (2000) 245–265.
- [81] S. Mystakidis, A. Christopoulos, N. Pellas, A systematic mapping review of augmented reality applications to support STEM learning in higher education, *Education and Information Technologies* (2021) 1–45.
- [82] Pinho, C., Franco, M., & Mendes, L. (2021). Application of innovation diffusion theory to the E-learning process: higher education context. *Education and Information Technologies*, 26(1), 421-440.
- [83] E.A. Tokareva, Y.V. Smirnova, L.G. Orshakova, Innovation and communication technologies: Analysis of the effectiveness of their use and implementation in higher education, *Education and Information Technologies* 24 (5) (2019) 3219–3234.
- [84] B.R. Robin, S.G. McNeil, D.A. Cook, K.L. Agarwal, G.R. Singhal, Preparing for the changing role of instructional technologies in medical education, *Acad. Med.* 86 (4) (2011) 435–439.
- [85] V. Bozalek, D. Ng'ambi, D. Gachago, Transforming teaching with emerging technologies: Implications for higher education institutions, *South African Journal of Higher Education* 27 (2) (2013) 419–436.
- [86] A. Brem, E. Viardot, P.A. Nylund, Implications of the coronavirus (COVID-19) outbreak for innovation: Which technologies will improve our lives? *Technological forecasting and social change* 163 (2021) 120451.
- [87] O.S. Abilmazhinova, M.Z. Janbubekova, O.G. Belenko, S.S. Abisheva, G.K. Kassymova, Development of creative abilities of students using art technologies in the higher education, *Ilkogretim Online* 20 (1) (2021).
- [88] O. Goltubev, V. Testov, Network information technologies as a basis of new educational paradigm, *Procedia-Social and Behavioral Sciences* 214 (2015) 128–134.
- [89] Hoyles, C., & Noss, R. (2003). What can digital technologies take from and bring to research in mathematics education?. *Second international handbook of mathematics education*, 323-349.



- [90] S. Lukyanov, N. Popov, I. Sikarev, E. Romyantseva, O. Petrieva, Digital learning technologies within geo-information management, *E3S Web of Conferences*, 258, EDP Sciences, 2021.
- [91] J. Vlieghe, Education in an age of digital technologies, *Philosophy & Technology* 27 (4) (2014) 519–537.
- [92] P. Anderson, A. Blackwood, Mobile and PDA technologies and their future use in education, *JISC Technology and Standards Watch* 4 (3) (2004) 3–33.
- [93] A.M. Syed, S. Ahmad, A. Alaraifi, W. Rafi, Identification of operational risks impeding the implementation of eLearning in higher education system, *Education and Information Technologies* 26 (1) (2021) 655–671.
- [94] A.A. Aleksandrov, K. Fang, A.V. Proletarsky, K.A. Neusypin, Conception of complex continuous education with innovative information technologies, in: *Education and Education Management*, 2012, pp. 374–378.
- [95] A. Kirkwood, L. Price, Examining some assumptions and limitations of research on the effects of emerging technologies for teaching and learning in higher education, *British Journal of Educational Technology* 44 (4) (2013) 536–543.
- [96] O.A. Abass, O.A. Arowolo, E.N. Igwe, Towards enhancing service delivery in higher education institutions via knowledge management technologies and blended e-learning, *International Journal on Studies in Education* 3 (1) (2021) 10–21.
- [97] Karimian, Z., Farrokhi, M. R., Moghadami, M., Zarifsanaiy, N., Mehrabi, M., Khojasteh, L., & Salehi, N. (2021). Medical education and COVID-19 Pandemic: a crisis management model towards an evolutionary pathway. *Education and Information Technologies*, 1-22.
- [98] L. Avraamidou, Prospects for the use of mobile technologies in science education, *AACE Journal* 16 (3) (2008) 347–365.
- [99] T.K. Shih, G.D. Antoni, T. Arndt, A. Asirvatham, C.T. Chang, Y.S. Chee, Y.H. Wang, A survey of distance education challenges and technologies, *International Journal of Distance Education Technologies (IJDET)* 1 (1) (2003) 1–20.
- [100] T. Fenwick, R. Edwards, Exploring the impact of digital technologies on professional responsibilities and education, *European Educational Research Journal* 15 (1) (2016) 117–131.
- [101] M.M.C. Shohel, M. Ashrafuzzaman, M.T. Islam, S. Shams, A. Mahmud, Blended Teaching and Learning in Higher Education: Challenges and Opportunities, in: *Handbook of Research on Developing a Post-Pandemic Paradigm for Virtual Technologies in Higher Education*, IGI Global, 2021, pp. 27–50.
- [102] R. Kop, Web 2.0 technologies: Disruptive or liberating for adult education, in: *Adult Education Research Conference*, 2008, June, pp. 5–7.
- [103] B. Williamson, R. Eynon, J. Potter, Pandemic politics, pedagogies and practices: digital technologies and distance education during the coronavirus emergency, *Learning, Media and Technology* 45 (2) (2020) 107–114.
- [104] H.M. LaMonica, T.A. Davenport, A.E. Roberts, L.B. Hickie, Understanding technology preferences and requirements for health information technologies designed to improve and maintain the mental health and well-being of older adults: Participatory design study, *JMIR aging* 4 (1) (2021) e21461.
- [105] M. del Carmen Ortega-Navas, The use of new technologies as a tool for the promotion of health education, *Procedia-Social and Behavioral Sciences* 237 (2017) 23–29.
- [106] G. Yildirim, M. Elban, S. Yildirim, Analysis of use of virtual reality technologies in history education: A case study, *Asian Journal of Education and Training* 4 (2) (2018) 62–69.
- [107] O. Zawacki-Richter, The current state and impact of Covid-19 on digital higher education in Germany, *Human Behavior and Emerging Technologies* 3 (1) (2021) 218–226.
- [108] I. Masic, H. Pandza, S. Toromanovic, F. Masic, S. Sivic, L. Zunic, Z. Masic, Information technologies (ITs) in medical education, *Acta Informatica Medica* 19 (3) (2011) 161.
- [109] J. Cabero-Almenara, F.D. Guillén-Gámez, J. Ruiz-Palmero, A. Palacios-Rodríguez, Digital competence of higher education professor according to DigCompEdu. Statistical research methods with ANOVA between fields of knowledge in different age ranges, *Education and Information Technologies* (2021) 1–18.
- [110] A.A. Korostelev, I.M. Morozova, M.L. Gruzdeva, Z.V. Smirnova, O.I. Vaganova, A.V. Chanchina, S.M. Maltseva, Modern information and communication technologies in the advanced education of children, *International Journal of Innovative Technology and Exploring Engineering* 8 (9) (2019) 2376–2382.
- [111] K.S. Halimovna, M.O. Nurilloevna, K.D. Radzhabovna, R.G. Shavkatovna, R.L. Hamidovna, The Role of Modern Pedagogical Technologies in the Formation of Students' Communicative Competence, *Religación* 4 (2021) 261–265.
- [112] L.A. Abriata, How Technologies assisted science learning at home during the COVID-19 Pandemic, *DNA Cell Biol.* 41 (1) (2022) 19–24.
- [113] V. Dhar, A. Sundararajan, Issues and Opinions—Information technologies in business: A blueprint for education and research, *Inf. Syst. Res.* 18 (2) (2007) 125–141.
- [114] L.H. Sokhulu, Students' experiences of using digital technologies to address their personal research needs during the COVID-19 lockdown, *African Identities* 19 (4) (2021) 436–452.
- [115] A. Hemmi, S. Bayne, R. Land, The appropriation and repurposing of social technologies in higher education, *Journal of computer-assisted learning* 25 (1) (2009) 19–30.
- [116] S.S. Ovunc, M.B. Yolcu, S. Emre, M. Elicevik, S. Celayir, Using Immersive Technologies to Develop Medical Education Materials, *Cureus* 13 (1) (2021).
- [117] E. Popescu, Students' acceptance of web 2.0 technologies in higher education: findings from a survey in a Romanian University, in: *2010 Workshops on Database and Expert Systems Applications*, IEEE, 2010, August, pp. 92–96.
- [118] M. Flavin, Disruptive technologies in higher education, *Research in Learning Technology* (2012) 20.
- [119] A.A. Cattaneo, C. Antonietti, M. Rauseo, How digitalised are vocational teachers? Assessing digital competence in vocational education and looking at its underlying factors, *Computers & Education* 176 (2022) 104358.
- [120] S. Papadakis, M. Kalogiannakis, Exploring preservice teachers' attitudes about the usage of educational robotics in preschool education, in: *Research Anthology on Computational Thinking, Programming, and Robotics in the Classroom*, IGI Global, 2022, pp. 807–823.
- [121] M. Volman, E. Van Eck, I. Heemskerk, E. Kuiper, New technologies, new differences. Gender and ethnic differences in pupils' use of ICT in primary and secondary education, *Computers & Education* 45 (1) (2005) 35–55.
- [122] M. Sherman, Y. Martynshyn, O. Khlystun, L. Chukhrai, Y. Kliuchko, U. Savkiv, Optimisation of the Educational Environment Using Information Technologies, *International Journal of Computer Science & Network Security* 21 (4) (2021) 80–83.
- [123] Kirkup, G., & Kirkwood, A. (2005). Information and communications technologies (ICT) in higher education teaching—a tale of gradualism rather than revolution. *Learning, media and technology*, 30(2), 185-199.
- [124] M.I. Zhaldak, V.M. Franchuk, N.P. Franchuk, Some applications of cloud technologies in mathematical calculations, *Journal of Physics: Conference Series*, IOP Publishing, 2021, March1840.
- [125] R.T. Clift, L. Mullen, J. Levin, A. Larson, Technologies in contexts: implications for teacher education, *Teaching and teacher education* 17 (1) (2001) 33–50.
- [126] K. Harry, A. Khan, The use of technologies in basic education, in: *Basic education at a distance*, Routledge, 2002, pp. 138–153.
- [127] I.E. Johnson, C.U. Nkanu, A.L. Udo, Checkmating the weaknesses associated with information and communication technologies in education for improved effectiveness and efficiency, *Journal of education and practice* 12 (8) (2021) 80–85.
- [128] M.N. Kamel Boulos, S. Wheeler, The emerging Web 2.0 social software: an enabling suite of sociable technologies in health and health care education 1, *Health Information & Libraries Journal* 24 (1) (2007) 2–23.
- [129] Y.H. Al-Anezi, S.M. Alajmi, Factors That Influence English Teachers' Acceptance and Use of E-Learning Technologies, *International Education Studies* 14 (9) (2021) 15–27.
- [130] S. Nuere, L. de Miguel, The digital/technological connection with Covid-19: An unprecedented challenge in university teaching, *Technology, Knowledge and Learning* 26 (4) (2021) 931–943.
- [131] E. Scanlon, K. Issroff, Activity theory and higher education: Evaluating learning technologies, *Journal of Computer Assisted Learning* 21 (6) (2005) 430–439.
- [132] M. Kalogiannakis, S. Papadakis, Combining mobile technologies in environmental education: a Greek case study, *International Journal of Mobile Learning and Organisation* 11 (2) (2017) 108–130.
- [133] O.E. Bolívar-Chávez, J. Paredes-Labra, Y.V. Palma-García, Y.A. Mendieta-Torres, Educational technologies and their application to music education: An action-research study in an Ecuadorian university, *Mathematics* 9 (4) (2021) 412.
- [134] L. Menabò, A. Sansavini, A. Brighi, G. Skrzypiec, A. Guarini, Promoting the integration of technology in teaching: An analysis of the factors that increase the intention to use technologies among Italian teachers, *Journal of Computer Assisted Learning* 37 (6) (2021) 1566–1577.
- [135] D.M. Bender, J.D. Vredevoogd, Using online education technologies to support studio instruction, *Journal of Educational Technology & Society* 9 (4) (2006) 114–122.
- [136] K. Watty, J. McKay, L. Ngo, Innovators or inhibitors? Accounting faculty resistance to new educational technologies in higher education, *Journal of Accounting Education* 36 (2016) 1–15.
- [137] M. Javaid, A. Haleem, R.P. Singh, M.I.U. Haq, A. Raina, R. Suman, Industry 5.0: Potential applications in COVID-19, *Journal of Industrial Integration and Management* 5 (04) (2020) 507–530.
- [138] C. Marinagi, C. Skourlas, P. Belsis, Employing ubiquitous computing devices and technologies in the higher education classroom of the future, *Procedia-Social and Behavioral Sciences* 73 (2013) 487–494.
- [139] I. Horváth, Disruptive technologies in higher education, in: *2016 7th IEEE International Conference on Cognitive Infocommunications (CogInfoCom)*, IEEE, 2016, October, pp. 000347–000352.
- [140] A.T. Olutola, O.O. Olatoye, Challenges of e-learning technologies in Nigerian university education, *Journal of Educational and Social Research* 5 (1) (2015) 301–301.
- [141] Zabiyeveva, K., Seitova, S., Andasbayev, Y. S., Tasbolatova, R., & Ibraeva, S. N. (2021). Methodology for using web technologies to develop the intellectual abilities of future mathematics teachers. *Thinking Skills and Creativity*, 41, 100904.
- [142] A. Saykili, Higher education in the digital age: The impact of digital connective technologies, in: *Journal of Educational Technology and Online Learning*, 2, 2019, pp. 1–15.
- [143] Kirriemuir, J. (2002). Video gaming, education and digital learning technologies. *D-lib Magazine*, 8(2), 7.
- [144] R. Fojtik, Mobile Technologies Education, *Procedia-Social and Behavioral Sciences* 143 (2014) 342–346.
- [145] K. Ordov, A. Madiyarova, V. Ermilov, N. Tovma, M. Murzagulova, New trends in education as the aspect of digital technologies, *International journal of mechanical engineering and technology* 10 (2) (2019) 1319–1330.
- [146] J. Swenson, C.A. Young, E. McGrail, R. Rozema, P. Whitin, Extending the conversion: New technologies, new literacies, and English education, *English Education* 38 (4) (2006) 351–369.
- [147] O. Ihnatova, K. Poseletska, D. Matiiuk, Y. Hapchuk, O. Borovska, The application of digital technologies in teaching a foreign language in a blended learning environment, *Linguistics and Culture Review* 5 (S4) (2021) 114–127.
- [148] K.S. Kumar, M. Mahendraprabu, Open educational practices of SWAYAM programme among research scholars, *Education and Information Technologies* (2021) 1–25.

- [149] E.D. Cassidy, A. Colmenares, G. Jones, T. Manolovitz, L. Shen, S. Vieira, Higher education and emerging technologies: Shifting trends in student usage, *The Journal of Academic Librarianship* 40 (2) (2014) 124–133.
- [150] T.R. Harris, J.D. Bransford, S.P. Brophy, Roles for learning sciences and learning technologies in biomedical engineering education: A review of recent advances, *Annu. Rev. Biomed. Eng.* 4 (1) (2002) 29–48.
- [151] J.B. Ergashev, M.B. Ergasheva, G.B. Samatova, Application of Information and Communication Technologies in Solving Geometric Problems, *Annals of the Romanian Society for Cell Biology* (2021) 4191–4197.
- [152] V.A. Goodyear, C. Kerner, M. Quennerstedt, Young people's uses of wearable healthy lifestyle technologies; surveillance, self-surveillance and resistance, *Sport, education and society* 24 (3) (2019) 212–225.
- [153] A.S. Anwar, U. Rahardja, A.G. Prawiyogi, N.P.L. Santoso, eLearning Model Approach in Creating Blockchain-Based Higher Education Trust, *International Journal of Artificial Intelligence Research* 6 (1) (2022).
- [154] J. Jin, S.M. Bridges, Educational technologies in problem-based learning in health sciences education: a systematic review, *Journal of medical internet research* 16 (12) (2014) e251.
- [155] E.N. Yadova, G. Bubnov, E. Pluzhnik, Efficient implementation of high technologies in the educational process, in: *SHS Web of Conferences*, 29, EDP Sciences, 2016, p. 02046.
- [156] D. Polly, F. Martin, T.C. Guilbaud, Examining barriers and desired supports to increase faculty members' use of digital technologies: perspectives of faculty, staff and administrators, *Journal of Computing in Higher Education* 33 (1) (2021) 135–156.
- [157] K. Aoki, Generations of distance education: Technologies, pedagogies, and organizations, *Procedia-Social and Behavioral Sciences* 55 (2012) 1183–1187.
- [158] I. Gorbunova, H. Hiner, Music computer technologies and interactive systems of education in digital age school, in: *Proceedings of the International Conference Communicative Strategies of Information Society, CSIS, 2019, February*, pp. 124–128. 2018.
- [159] Qashou, A. (2021). Influencing factors in M-learning adoption in higher education. *Education and information technologies*, 26(2), 1755-1785.
- [160] F.X. Xazratov, Model of formation of information culture of the future geography teacher on the basis of geoformation technologies, in: *International Conference on Multidisciplinary Research and Innovative Technologies*, 1, 2021, August, pp. 103–105.
- [161] M. Hernandez-de-Menendez, C. Escobar Díaz, R. Morales-Menendez, Technologies for the future of learning: state of the art, *International Journal on Interactive Design and Manufacturing (IJIDeM)* 14 (2) (2020) 683–695.
- [162] B. Erol, Y. Li, An overview of technologies for e-meeting and e-lecture, 2005 IEEE International Conference on Multimedia and Expo, IEEE, 2005, July 6–pp.
- [163] L.F. Johnson, A. Levine, R.S. Smith, K. Haywood, Key emerging technologies for elementary and secondary education, *The Education Digest* 76 (1) (2010) 36.
- [164] Li, Q., Li, Z., & Han, J. (2021). A hybrid learning pedagogy for surmounting the challenges of the COVID-19 Pandemic in the performing arts education. *Education and Information Technologies*, 26(6), 7635-7655.
- [165] P. Rogerson-Revell, Constructively aligning technologies with learning and assessment in a distance education master's programme, *Distance Education* 36 (1) (2015) 129–147.
- [166] X. Chen, D. Zou, G. Cheng, H. Xie, Detecting latent topics and trends in educational technologies over four decades using structural topic modeling: A retrospective of all volumes of *Computers & Education*, *Computers & Education* 151 (2020) 103855.
- [167] M.W. Marek, C.S. Chew, W.C.V. Wu, Teacher experiences in converting classes to distance learning in the COVID-19 Pandemic, *International Journal of Distance Education Technologies (IJDET)* 19 (1) (2021) 40–60.
- [168] R.P. Singh, M. Javaid, R. Kataria, M. Tyagi, A. Haleem, R. Suman, Significant applications of virtual reality for COVID-19 Pandemic, *Diabetes & Metabolic Syndrome: Clinical Research & Reviews* 14 (4) (2020) 661–664.
- [169] S. Nikou, M. Aavakare, An assessment of the interplay between literacy and digital technology in higher education, *Education and Information Technologies* (2021) 1–23.
- [170] V. Curran, L. Matthews, L. Fleet, K. Simmons, D.L. Gustafson, L. Wetsch, A review of digital, social, and mobile technologies in health professional education, *J. Contin. Educ. Health. Prof.* 37 (3) (2017) 195–206.
- [171] L. Rueda, J. Benitez, J. Braojos, From traditional education technologies to student satisfaction in Management education: A theory of the role of social media applications, *Information & Management* 54 (8) (2017) 1059–1071.
- [172] Z.S. Hejrati, M. Gaim, C.E. Easley, T.K. Dang, Use of MOOC and Digital Technologies to Study Effects of Liability of Foreignness on Venture Formation in Forced Immigration-Case Study of Refugee Entrepreneurship in Ethiopia, in: *2021 IEEE 4th International Conference on Information Systems and Computer-Aided Education (ICISCAE)*, IEEE, 2021, September, pp. 54–61.
- [173] R. Chaker, M.A. Impedovo, The moderating effect of social capital on co-regulated learning for MOOC achievement, *Education and Information Technologies* 26 (1) (2021) 899–919.
- [174] H. A. C. Alario-Hoyos, M. Pérez-Sanagustín, C. Delgado-Kloos, G. Parada, M. Muñoz-Organero, A. Rodríguez-De-Las-Heras, Analysing the impact of built-in and external social tools in a MOOC on educational technologies, in: *European Conference on Technology Enhanced Learning*, Springer, Berlin, Heidelberg, 2013, September, pp. 5–18.
- [175] C.D. Kloos, P.J. Muñoz-Merino, C. Alario-Hoyos, I.E. Ayres, C. Fernández-Panadero, Mixing and blending MOOC Technologies with face-to-face pedagogies, in: *2015 IEEE Global Engineering Education Conference (EDUCON)*, IEEE, 2015, March, pp. 967–971.
- [176] J. Riel, K.A. Lawless, Developments in MOOC Technologies and Participation Since 2012, in: *Encyclopedia of Information Science and Technology*, Fourth Edition, IGI Global, 2018, pp. 7888–7897.
- [177] C. Giovannella, Effect induced by the Covid-19 Pandemic on students' perception about technologies and distance learning, in: *Ludic, Co-design and tools supporting smart learning ecosystems and smart education*, Springer, Singapore, 2021, pp. 105–116.
- [178] N. Burbules, T. Callister, Universities in transition: The promise and the challenge of new technologies, *Teachers College Record* 102 (2) (2000) 271–293.
- [179] E. Sosa, J. Salinas, B. De Benito, Emerging technologies (ETs) in education: A systematic review of the literature published between 2006 and 2016, *International Journal of Emerging Technologies in Learning*, 2017 12 (5) (2017) 128–149 num.
- [180] D.A. Harris, C. Kroussgrill, Distance education: New technologies and new directions, in: *Proceedings of the IEEE*, 96, 2008, pp. 917–930.
- [181] I.A. Leontyeva, Modern distance learning technologies in higher education: Introduction problems, *Eurasia journal of mathematics, science and technology education* 14 (10) (2018) em1578.
- [182] M.L. Owoc, A. Sawicka, P. Weichbroth, Artificial intelligence technologies in education: benefits, challenges and strategies of implementation, in: *IFIP International Workshop on Artificial Intelligence for Knowledge Management*, Springer, Cham, 2019, August, pp. 37–58.
- [183] J. Pryor, J.G. Ampiah, F. Aidoo, K. Boadu, E. Opoku-Darku, M. Burkle, S. Meredith, Understandings of education in an African village, *The impact of information and communication technologies* (2003) 666-2016-45496.
- [184] E.A. Barakhsanova, V.M. Savvinov, M.S. Prokopyev, E.Z. Vlasova, I.B. Gosudarev, Adaptive education technologies to train Russian teachers to use e-learning, *International electronic journal of mathematics education* 11 (10) (2016) 3447–3456.
- [185] T.B. Bati, A.W. Workneh, Evaluating integrated use of information technologies in secondary schools of Ethiopia using design-reality gap analysis: A school-level study, *The electronic journal of information systems in developing countries* 87 (1) (2021) e12148.
- [186] K. Facer, Personal, relational and beautiful: education, technologies and John Macmurray's philosophy, *Oxford Review of Education* 38 (6) (2012) 709–725.
- [187] N. Saeed, Y. Yang, S. Sinnappan, Emerging web technologies in higher education: A case of incorporating blogs, podcasts and social bookmarks in a web programming course based on student's learning styles and technology preferences, *Journal of Educational Technology & Society* 12 (4) (2009) 98–109.
- [188] G.L. Tortorella, G. Narayanamurthy, P.A. Cauchick-Miguel, Operations Management teaching practices and information technologies adoption in emerging economies during COVID-19 outbreak, *Technological Forecasting and Social Change* 171 (2021) 120996.
- [189] L.A. Petrides, Web-based technologies for distributed (or distance) learning: Creating learning-centred educational experiences in the higher education classroom, *Int. J. Instr. Media* 29 (1) (2002) 69.
- [190] G. Mosely, J. Harris, K. Grushka, Design education in schools: an investigation of the Australian Curriculum: Technologies, *Int. J. Technol. Des. Educ.* 31 (4) (2021) 677–695.
- [191] J. Cohen, Maker principles and technologies in teacher education: A national survey, *Journal of Technology and Teacher Education* 25 (1) (2017) 5–30.
- [192] S. Hartong, Between assessments, digital technologies and big data: The growing influence of 'hidden data mediators in education, *European Educational Research Journal* 15 (5) (2016) 523–536.
- [193] J.F. Kalolo, Digital revolution and its impact on education systems in developing countries, *Education and Information Technologies* 24 (1) (2019) 345–358.
- [194] T. Wang, Rethinking teaching with information and communication technologies (ICTs) in architectural education, *Teaching and Teacher Education* 25 (8) (2009) 1132–1140.
- [195] V. Mkrtrchian, L. Gamidullaeva, A. Finogeev, S. Chernyshenko, V. Chernyshenko, D. Amirov, I. Potapova, Big data and internet of things (IoT) technologies' influence on higher education: current state and future prospects, *International Journal of Web-Based Learning and Teaching Technologies (IJWLTT)* 16 (5) (2021) 137–157.
- [196] M. Divitini, O.K. Haugalokken, P.A. Norevik, Improving communication through mobile technologies: Which possibilities? in: *Proceedings. IEEE International Workshop on Wireless and Mobile Technologies in Education*, IEEE, 2002, August, pp. 86–90.
- [197] M.K. Islam, M.F.H. Sarker, M.S. Islam, Promoting student-centred blended learning in higher education: A model, *E-Learning and Digital Media* 19 (1) (2022) 36–54.
- [198] N. Davis, The globalisation of education through teacher education with new technologies: A view informed by research through teacher education with new technologies, *AACE Review (formerly AACE Journal)* (2020) 8–12.
- [199] M. Gysels, I.J. Higginson, Interactive technologies and videotapes for patient education in cancer care: systematic review and meta-analysis of randomised trials, *Support. Care Cancer* 15 (1) (2007) 7–20.
- [200] A. Choudhury, K.K. Sarma, Visual gesture-based character recognition systems for design of assistive technologies for people with special necessities, in: *Research Anthology on Physical and Intellectual Disabilities in an Inclusive Society*, IGI Global, 2022, pp. 264–285.
- [201] R.K. Yin, G.B. Moore, The use of advanced technologies in special education: Prospects from robotics, artificial intelligence, and computer simulation, *J. Learn. Disabil.* 20 (1) (1987) 60–63.
- [202] S.H. Fuegen, The impact of mobile technologies on distance education, *TechTrends* 56 (2012) 49–53.
- [203] C. Durrant, B. Green, Literacy and the new technologies in school education: meeting the I (IT) literacy challenge? *Australian Journal of Language and Literacy*, The 23 (2) (2000) 89–108.

- [204] E. Al-Zboon, Assistive technologies as a curriculum component in Jordan: Future special education teachers' preparation and the field status, *Assist. Technol.* (2021) 1–6.
- [205] M. Kesim, Y. Ozarslan, Augmented reality in education: current technologies and the potential for education, *Procedia-social and behavioral sciences* 47 (2012) 297–302.
- [206] L. Chittaro, R. Ranon, Web3D technologies in learning, education and training: Motivations, issues, opportunities, *Computers & Education* 49 (1) (2007) 3–18.
- [207] A. Mehrfard, J. Fotouhi, G. Taylor, T. Forster, M. Armand, N. Navab, B. Fuerst, Virtual reality technologies for clinical education: evaluation metrics and comparative analysis, *Computer Methods in Biomechanics and Biomedical Engineering: Imaging & Visualisation* 9 (3) (2021) 233–242.
- [208] C.C. Lewis, C.E. Fretwell, J. Ryan, J.B. Parham, Faculty use of established and emerging technologies in higher education: A unified theory of acceptance and use of technology perspective, *International Journal of Higher Education* 2 (2) (2013) 22–34.
- [209] N. Bergdahl, J. Nouri, Covid-19 and crisis-prompted distance education in Sweden, *Technology, Knowledge and Learning* 26 (3) (2021) 443–459.
- [210] S. Bennett, A. Bishop, B. Dalgarno, J. Waycott, G. Kennedy, Implementing Web 2.0 technologies in higher education: A collective case study, *Computers & Education* 59 (2) (2012) 524–534.
- [211] B. Shilpa, R. Radha, P. Movva, Comparative Analysis of Wireless Communication Technologies for IoT Applications, in: *Artificial Intelligence and Technologies*, Springer, Singapore, 2022, pp. 383–394.
- [212] J. Seale, J. Georgeson, C. Mamas, J. Swain, Not the right kind of 'digital capital'? An examination of the complex relationship between disabled students, their technologies and higher education institutions, *Comput. Educ.* 82 (2015) 118–128.
- [213] T. Štemberger, S.Č. Konrad, Attitudes Towards using Digital Technologies in Education as an Important Factor in Developing Digital Competence: The Case of Slovenian Student Teachers, *Int. J. Emerg. Technol. Learn. (iJET)* 16 (14) (2021) 83–98.
- [214] L. Mifsud, Alternative learning arenas-pedagogical challenges to mobile learning technology in education, in: *Proceedings. IEEE International Workshop on Wireless and Mobile Technologies in Education, IEEE, 2002, August*, pp. 112–116.
- [215] T.V. Gromova, Information Technologies Significance in Higher Education in Context of Its Digitalisation, in: *Current Achievements, Challenges and Digital Chances of Knowledge-Based Economy*, Springer, Cham, 2021, pp. 19–26.
- [216] K. Masters, R.H. Ellaway, D. Topps, D. Archibald, R.J. Hogue, Mobile technologies in medical education: AMEE Guide No. 105, *Med. Teach.* 38 (6) (2016) 537–549.
- [217] A. Bařal, A. Eryılmaz, Engagement and affection of pre-service teachers in online learning in the context of COVID 19: engagement-based instruction with web 2.0 technologies vs direct transmission instruction, *J. Educ. Teach.* 47 (1) (2021) 131–133.
- [218] C. Njoku, Information and communication technologies to raise the quality of teaching and learning in higher education institutions, *Int. J. Educ. Dev. Using ICT* 11 (1) (2015).
- [219] S. Criollo-C, A. Guerrero-Arias, Á. Jaramillo-Alcázar, S. Luján-Mora, Mobile Learning Technologies for Education: Benefits and Pending Issues, *Appl. Sci.* 11 (9) (2021) 4111.