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Review

The Influence of Emerging Technologies on Distance Education

Magdalena Garlinska [1,†], Magdalena Osial [1], Klaudia Proniewska [2,3] and Agnieszka Pregowska [1,*,†]

[1] Institute of Fundamental Technological Research, Polish Academy of Sciences, Pawinskiego 5B, 02-106 Warsaw, Poland
[2] Center for Digital Medicine and Robotics, Jagiellonian University Medical College, Kopernika 7E Str., 31-034 Krakow, Poland
[3] Department of Bioinformatics and Telemedicine, Jagiellonian University Medical College, Medyczna 7 Str., 30-688 Krakow, Poland
* Correspondence: aprego@ippt.pan.pl; Tel.: +48-22-826-1281 (ext. 412)
† These authors contributed equally to this work.

Abstract: Recently, during the COVID-19 pandemic, distance education became mainstream. Many students were not prepared for this situation—they lacked equipment or were not even connected to the Internet. Schools and government institutions had to react quickly to allow students to learn remotely. They had to provide students with equipment (e.g., computers, tablets, and goggles) but also provide them with access to the Internet and other necessary tools. On the other hand, teachers were trying to adopt new technologies in the teaching process to enable more interactivity, mitigate feelings of isolation and disconnection, and enhance student engagement. New technologies, including Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), Extended Reality (XR, so-called Metaverse), Big Data, Blockchain, and Free Space Optics (FSO) changed learning, teaching, and assessing. Despite that, some tools were implemented fast, and the COVID-19 pandemic was the trigger for this process; most of these technologies will be used further, even in classroom teaching in both schools and universities. This paper presents a concise review of the emerging technologies applied in distance education. The main emphasis was placed on their influence on the efficiency of the learning process and their psychological impact on users. It turned out that both students and teachers were satisfied with remote learning, while in the case of undergraduate children and high-school students, parents very often expressed their dissatisfaction. The limitation of the availability of remote learning is related to access to stable Internet and computer equipment, which turned out to be a rarity. In the current social context, the obtained results provided valuable insights into factors affecting the acceptance and emerging technologies applied in distance education. Finally, this paper suggests a research direction for the development of effective remote learning techniques.

Keywords: distance education; artificial intelligence (AI); virtual reality; augmented reality; mixed reality; free space optics (FSO); blockchain; big data

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1. Introduction

Before the COVID-19 pandemic, distance education was an option, not a necessity, for most students. Then, from March 2020, to stem the transmission of COVID-19, the lockdown was implemented in most countries, and establishments were closed, including schools. Thus, the education system adopted distance learning, actually day by day. Please note that not all facilities were prepared for such activities [1]. According to UNESCO, the lockdowns and pandemic most affected students in the most difficult financial situation [2]. In the case of distance education, the teaching and learning processes happen remotely with the use of software and hardware that enables students to remotely connect with teachers. Nowadays, in this case, no longer only computers and Internet connections are used. On the market, there are different available tools developed to make this teaching process easier and more flexible [3]. Recently, we have so-called Technology-Enhanced Learning (TEL) [4,5]. It can be completely remote or combined with traditional teaching [6].

Distance education can be classified into two categories: asynchronous and synchronous learning [7,8]. Asynchronous distance learning is based on the interactions between the teacher and the learner at different times, such as learning from paper instructions, listening to recorded lectures, or watching pre-recorded visual tutorials. Synchronous learning requires interactions in real time, such as attending live online lectures [9]. Both methods became popular, and the selection of proper methods used in teaching depends on the knowledge that the learner wants to gain. Nowadays, a mix of synchronous and asynchronous teaching is the most popular. Classes are performed online, and students have direct contact with teachers via communicators [10]. However, students receive additional training materials to prepare homework or supplement knowledge during their free time. These materials can be in the form of text files and digital books but also presentations, videos, or tasks to be performed in dedicated software. Several decades ago, to study in a given field, people had to attend classes physically, and it was impossible to start their studies without passing classifying exams. Now, people just need to spend a few minutes registering online, and they can attend world-class lectures available for everyone from everywhere without leaving their houses [11].

Remote learning has many advantages, thanks to which it is increasingly used in education, even after the end of the COVID-19 pandemic. It also has disadvantages, but they are getting smaller with the development of technology [12]. Thanks to the development of new technologies, participation in classes does not require high participation costs and enables a variety of teaching forms and methods [13]. Children and parents do not spend time commuting to school, and the child after lessons does not have to stay in the common room waiting to return home. Remote learning can be based on the voluntary choice of time, place, pace of learning, and the number of participants. The advantages of distance learning include quick access to materials, the ability to check the students' knowledge on an ongoing basis, the individualization of the learning process, the possibility of working in a group, and direct interaction between the student and the teacher. However, it must not be forgotten that one of the most significant advantages of full-time study is constant and direct contact between the student and lecturer. It is challenging to replace this, even with the latest technology, and the practical knowledge that is fundamental to several professions cannot be replaced. The teacher, especially in the early stages of education, such as elementary or high school, is responsible for teaching children. Often, through direct contact with the student and observation of their behavior, a teacher can assess whether a child has problems, e.g., at home or with friends, and can react quickly [14]. Furthermore, a child studying at school has contact with their peers, which significantly impacts their development. Moreover, distance education cannot replace practical workshops, where manual skills are taught [15]. However, it should be emphasized that, in situations where access to education is limited, e.g., by the COVID-19 pandemic, distance learning provides a worthwhile alternative [16].

However, access to distance learning is inextricably linked to the development and access to various types of technologies [17–19]. Thus, the COVID-19 pandemic was conducive to the development of various types of remote conference tools (RCT), including educational such as VoiceThread [20], Intranet, and Moodle [20], and communication platforms such as MS Teams, Google G platforms Suite, Zoom, Skype, BigBlueButton, WebEx, and Smart Class [21–24]. On the other hand, undoubtedly, immersive technology, including Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), and Extended Reality (XR, so-called Metaverse), offers help in understanding complex concepts [25,26]. They also introduce the possibility of active interaction in three-dimensional space during classes between students and lecturers. In this paper, we discuss the recent solutions for applying distance education. We present different information and communication technologies, including VR/AR/MR/XR, Big Data, Blockchain, and Free Space Optics (FSO) in the context of distance learning, in particular remote learning formula, as well as the analysis of current trends and challenges. The paper also addresses a specific gap in the field, as the use of emerging technologies in distance education is a relatively new area of research.

As the field continues to evolve, it is essential to understand how these technologies are impacting the field of distance education and how they can be leveraged to enhance the learning experience for students.

2. Materials and Methods

The review methodology was based on PRISMA Statement [27] and its extensions: PRISMA-S [28,29], as well as our personal experience. We considered recent publications, reports, protocols, and review papers from Scopus and Web of Science databases, as well as the websites or selected government and European Union documents. The documents used in this presented study were selected based on the procedure presented in Figure 1. The keywords: new technologies + distance learning, remote learning, distance education, online courses, and their variations. The selected sources were analyzed in terms of compliance with the analyzed topic and then their contribution to distance learning. Finally, 208 documents were taken into account.

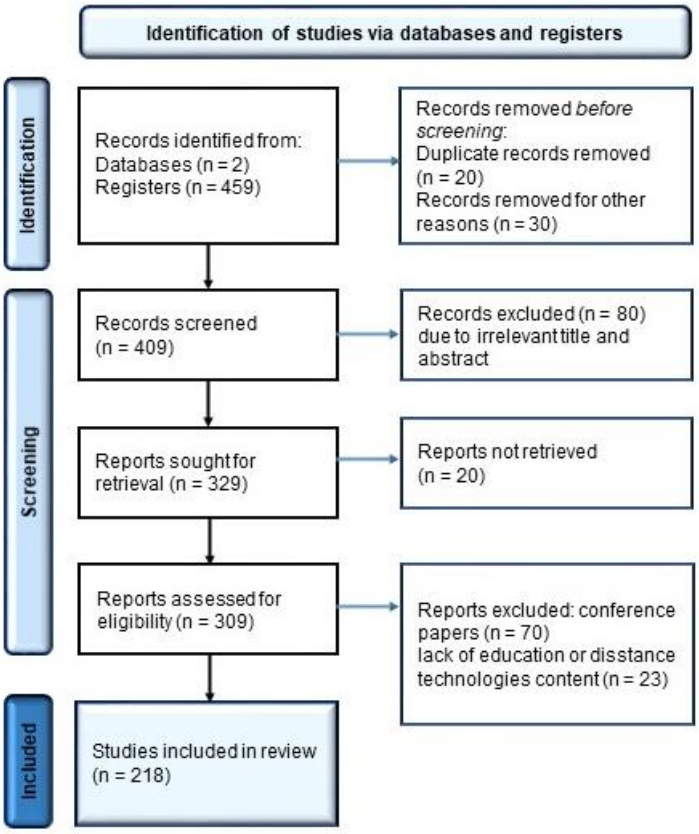

Figure 1. Literature search flowchart.

3. Results

Software technology has had a profound impact on distance education, providing a range of tools and resources that enhance the learning experience and make it easier for students and instructors to collaborate and communicate. In distance learning, apart from the hardware, it is necessary to use appropriate software—communication platforms, digital libraries, etc. Common software solutions for communication in distance learning include Learning Management Systems (LMS), Video Conferencing tools (VCs), Adaptive Learning Software, Online Quizzing, and Assessment Tools. LMS platforms provide a centralized hub for course materials, assignments, assessments, and student records. Adaptive learning software uses data analytics to provide individualized learning experiences based on each student's strengths, weaknesses, and learning styles. Online quizzing and assessment tools provide students with the ability to test their knowledge and receive instant feedback.

If we are talking about the use of new technologies in the distance learning process, first of all, attention should be paid to the safety of students, as well as the need to teach children the correct rules for using these devices. All equipment from the chair and desk to monitors, VR goggles, and others should not only be adjusted to the age of the child but also used appropriately—the right distance between the monitor and the eyes, a comfortable chair, good lighting of the study area, breaks in learning to rest the eyes and allow the child to stretch, the limited time of use of the monitors, etc. On the other hand, the same issues apply to teachers. In addition, it should be emphasized that the equipment used by students and teachers must meet the requirements of remote teaching. It must have a good graphics card, a good processor, working memory, software for work, antivirus, access to sufficiently fast Internet, and in the case of children, possibly a parental control application. Children and teachers should be properly trained in the principles of using all equipment before the start of classes to not disrupt ongoing classes with technical problems and, secondly, not stress them with the use of new technologies. It is also important to properly control the content provided by teachers during classes. Therefore, it may be necessary not only to receive the appropriate cybersecurity training but also in the field of cyberbullying because the materials (videos) presented during the lessons must not contain content that harms the development of the students' psyche. Some of the latest technologies already used in distance learning are described below, as well as a new solution for solving the so-called last mile problem in terms of Internet access—a Free Space Optics link.

Another aspect is connected to this: the introduction of new technologies and the age of users. When introducing new technologies to students of different age groups, it is important to consider their developmental needs and learning styles. For young children (ages 3–5), new technologies should be simple, colorful, and interactive. They should have large buttons and simple navigation to make it easy for them to use. Educational games and apps that focus on basic concepts, such as letters, numbers, and colors, can help children develop important skills in a fun and engaging way [30,31]. For elementary school students (ages 6–11), new technologies should be designed to support their development of key skills such as reading, writing, and math. Educational games and apps that incorporate storytelling, creativity, and problem-solving can help children learn and retain information more effectively [32]. For middle school students (ages 12–14), new technologies should provide opportunities for self-directed learning and experimentation. They should have access to a range of tools and resources that support inquiry-based learning, such as research databases and collaboration tools [33]. For high school students (ages 15–18), new technologies should focus on preparing them for higher education and the workforce. They should have access to a range of software applications and tools that support research, collaboration, and communication [34]. They should also be provided with opportunities to develop technical skills such as coding and web design [35]. For college and university students, new technologies should support their learning and research activities [36]. This may include access to online databases, virtual classrooms, and collaboration tools. They should also be provided with opportunities to develop digital literacy and technical skills that will be valuable in their future careers [37]. So, introducing new technologies to students of different age groups requires careful consideration of their developmental needs and learning styles. By designing age-appropriate technologies and supporting key learning objectives, educators can help students develop the skills they need to succeed in the digital age.

3.1. Small Accessories—A Big Change in Teaching Quality

The use of hardware technology has had a significant impact on distance education, providing students and instructors with the tools and resources they need to collaborate, communicate, and learn from a distance. Distance learning requires not only a laptop and access to the Internet. It may require plenty of accessories to make this process easier and more efficient. Here, we briefly described some of the hardware solutions that have been developed specifically for distance education and the benefits they offer.

Laptops and Tablets. Laptops and tablets have become essential tools for students and instructors in distance education, providing a portable and convenient way to access course materials, communicate with others, and complete assignments.

Virtual Reality/Augmented Reality/Mixed Reality head-mounted display (HMD) or headset. Thus, immersive technology-based devices can be split into four categories: headsets, holographic displays, smart glasses, or handheld devices [38]. HMD headsets are becoming increasingly popular in distance education, providing students with immersive and interactive learning experiences. Immersive technology enables students to experience a wide range of environments and scenarios, making learning more engaging and memorable. Currently, there are several VR/AR devices on the market today, namely Oculus Quest 2 [39], Pico 4 [40], HTC Vive [41], Meta Quest Pro [42], Pimax Reality [43], Snapdragon XR2 HMD [44], Lenovo ThinkReality VRX [45], AjnaLens AjnaXR [46], and MR devices such as Microsoft HoloLens 2 [47] and Lynx-R1 [48]. In Table 1, the comparison of commonly used head-mounted displays based on immersive technologies has been conducted.

Table 1. The comparison of the commonly used immersive technologies devices.

Feature	VR (Virtual Reality)	AR (Augmented Reality)	MR (Mixed Reality)
Definition	A completely computer-generated environment that a user can interact with	A blend of real and virtual environments, where virtual objects are superimposed over the real world	A hybrid environment that combines the physical and virtual world, where virtual objects can interact with the real world
Technology	Head-mounted displays (HMDs) or standalone VR devices	Smart glasses or smartphone apps	Smart glasses, HMDs, or handheld devices
Examples	Oculus Quest, PlayStation VR, HTC Vive	Google Glass, Microsoft Hololens, Snapchat filters	Microsoft Hololens 2, Magic Leap 1, Nreal Light
Immersion	High immersion	Limited immersion	High immersion
Interaction	Interaction with virtual objects and environments through controllers or hand tracking	Interaction with virtual objects through gestures or gaze control	Interaction with virtual objects and physical objects through gestures, voice, or hand tracking
Display	High-resolution display, wide field of view	Limited field of view, small displays	Wide field of view, high-resolution displays

Webcams. Webcams provide a simple and effective way for students and instructors to communicate and collaborate in real-time, regardless of location. They are an essential tool for video conferencing and other forms of remote communication in distance education.

Digital Whiteboards. Digital whiteboards provide a convenient and interactive way for students and instructors to collaborate and share ideas in real-time [49]. They can be used for presentations, brainstorming sessions, and other forms of collaboration, making it easier for distance learners to participate and engage with their peers [50].

Interactive Touch Displays. Interactive touch displays provide a high-tech alternative to traditional whiteboards and chalkboards, offering a more interactive and engaging learning experience [51]. They are ideal for use in online classes and distance education programs, providing students with a dynamic and interactive way to learn and explore new concepts.

Hardware technology has had a major impact on distance education, providing students and instructors with the tools and resources they need to collaborate, communicate, and learn from a distance. As technology continues to evolve, we will likely see even more innovative hardware solutions emerging to support distance education and enhance the learning experience.

Distance learning requires not only a laptop and access to the Internet. It may require plenty of accessories to make this process easier and more efficient. For instance, students

at home can be easily distracted, so they can use headphones with an external microphone that allows the user to be easily understood when speaking to someone in an online conversation. Such headphones can be also equipped with an ANC system (Active Noise Canceling) that enables noise-cancelation of background noises and other distractions. If students do not want to use headphones, a portable wireless Bluetooth speaker will be a good option because the sound quality will be better than traditional built-in laptop speakers. Additionally, on the market, special graphic tablets are available that translate the strokes from a pen or stylus to your computer screen with much greater precision. Such a tablet is far more natural and comfortable to use than a mouse or touchpad, whether a student needs to paint, illustrate, or even prepare a chart.

Additionally, when a few kids are taking classes online, a Wi-Fi range extender can be used. This handy device reduces the chance a student will be kicked off the computer during a lesson, and also kids can take classes in a separate room to not disrupt each other.

3.2. Video-Assisted Learning

In recent years, video-assisted learning (VAL) has become increasingly popular. Teachers use not only ready-made videos available on various platforms such as YouTube [52], ViewSonic [53], and myViewBoard [54] and prepare their videos, e.g., showing how to conduct chemical or physics experiments. Students enjoy watching such videos, they can focus on them when they are not too long, and if necessary, they can replay them to pay attention to the relevant details [55,56]. Thanks to the inclusion of videos, lessons are enriched, they become more interesting, and the content presented is more understandable [57]. This can help to improve students' assessment performance but also reduces the workload on teachers. In addition, teachers do not have to use only their materials, but present videos of teachers and scientists from around the world, if copyright law allows it. New technologies enable the preparation of interesting films not only by teachers but also by students at home as, for example, material for passing a given subject. There is no need to incur high costs for recording; such a film can be shot even with a mobile phone and edited using free applications. There are also relatively cheap lighting or sound systems available on the market to make these films even more professional.

3.3. Free Space Optics

Fast communication is of high importance in the case of distance education, while distance communication made it possible to transfer professional and partly even private life to the network. For effective and reliable communication, it is necessary to provide the appropriate resources. This is especially important in areas where it is impossible to route cables and optical fibers for various reasons. Here, Free-Space Optical Communication (FSOC), also called Outdoor Wireless optical communication, seems to be a promising solution due to secure, high-directionality, and high-bandwidth communication between mobile nodes [58]. Recently, the increased data demand and crowded radio frequency spectrum have become crucial issues. Thus, FSOC has diametrically changed the way people exchange information. Free-Space Optics Communication is a data transmission technology, which is based on light propagation in free space. As an alternative to wire communication systems, it allows efficient voice, video, and data transmission using a medium such as air. Due to large bandwidth, FSOC can be used in various applications, and hence it has become an important part of our everyday life. It takes full advantage of linking high-speed connections with energy efficiency, compact size, and low costs of installation, maintenance, and operation to provide an enhancement in the communication systems accessibility [59]. Moreover, there is no requirement for a spectrum license, which enables quite easy and low-cost development. It also provides unprecedented levels of data transmission security. The main advantage of FSOs is their wide application field, which includes outdoor wireless access, backhaul, fiber backup, last-mil, bridging WAN, and military access [60]. Unfortunately, FSOC is susceptible to disruption due to atmospheric conditions or direct sunlight [61].

In commercial FSO communication systems, strictly defined wavelengths of about 0.8 µm and 1.5 µm are used. Their selection is dependent on the characteristics of the atmosphere, attenuation, and the availability of sources and detectors of optical radiation. The development of quantum cascade (QC) lasers operating in long-wave infrared radiation [62–64] and highly sensitive mercury cadmium telluride detectors (MCT) gave new possibilities for FSO links. It has become possible to develop an FSO link operating at wavelengths 8–12 µm, where there is less attenuation caused by mists with fine aerosol particles than in the case of commercially available links [65–68]. These links are also safe for eyesight. Additionally, hybrid FSO/Radio Frequency (RF) communication systems are available that are less sensitive to weather conditions, extend the link range to longer distances, and open a much larger metro/access market to the carriers. Such systems can be used for communication purposes in hours and in the lesser economy to provide access to the Internet to students living without it. Free Space Optics (FSO) communication technology is a promising solution for distance education, offering several advantages over traditional wired and wireless communication methods [67].

High Speed. FSO offers data transmission speeds of up to several gigabits per second, providing a high-speed connection that is ideal for distance education. This fast connection ensures smooth and uninterrupted communication between students and instructors, even when working on large and complex projects.

Secure Communication. FSO uses laser technology to transmit data through the air, making it nearly impossible for unauthorized users to intercept the transmission. This security feature is essential for protecting sensitive information, particularly in the context of distance education.

Reliable Communication. FSO uses line-of-sight communication, which minimizes the risk of interference and enables reliable communication even in challenging environmental conditions. This is particularly important for distance education, where a reliable connection is essential for successful collaboration and learning.

Cost-Effective. FSO provides a cost-effective alternative to traditional wired and wireless communication methods, especially for remote or rural areas where these technologies may be unavailable or too expensive to install. FSO is also easy to install and maintain, reducing the overall cost of implementation and maintenance over time.

Flexibility. FSO can be used in a variety of environments, including urban, rural, and remote areas. This flexibility makes it a suitable solution for distance education programs that may require communication between different locations and a wide range of students.

FSO communication technology offers several advantages over traditional wired and wireless communication methods for distance education. Its high speed, secure communication, reliable connectivity, cost-effectiveness, and flexibility make it an ideal solution for educational institutions looking to enhance their distance education programs.

3.4. 5G Technology

The introduction of 5G technology has brought about many advancements in various fields, including education. With its increased speed and reliability, 5G has the potential to revolutionize distance education. With the advent of the Internet and other technological advancements, distance education has become increasingly popular in recent years, but many students and educators still face "network" challenges, such as limited bandwidth and unreliable connections. Thus, 5G can help address these issues and provide a better overall experience for both students and teachers. One of the key benefits of 5G in distance education is its ability to provide faster and more stable connections. This means that students can access educational content in real-time and without any lagging or buffering, which can be especially useful for live-streamed lectures or online discussions. The 5G technology can also support high-quality video and audio, allowing for a more immersive learning experience [68].

In addition, 5G can provide a more scalable and flexible infrastructure for distance education. It can support a large number of users at the same time, making it possible

for students from different parts of the world to participate in the same online class. This can help create a more diverse and inclusive learning environment, where students from different backgrounds and cultures can interact and learn from each other [69]. Another advantage of 5G in distance education is its ability to support various educational technologies, such as Virtual and Augmented Reality [70]. These technologies can provide students with a more interactive and engaging learning experience and can help make complex topics easier to understand. For example, Virtual Reality or other immersive technologies can be used to create immersive simulations of real-world scenarios, while Augmented Reality can be used to provide students with real-time feedback and assistance. Here, we briefly described the application of 5G in distance education. As 5G technology continues to evolve and become more widely available, we will likely see even more innovative and impactful uses in the future. Furthermore, 5G can support high-quality video and audio streaming, allowing students to attend live-streamed lectures from remote locations. This can be especially useful for students who cannot physically attend a lecture due to geographical barriers or other reasons. Additionally, 5G can support the use of virtual and augmented reality technologies in distance education, providing students with a more interactive and immersive learning experience. For example, virtual field trips can be used to take students to places they may not otherwise be able to visit. Moreover, 5G can be used for real-time communication and collaboration between students and teachers, allowing for more dynamic and engaging learning experiences. For example, students can participate in virtual group discussions, where they can share their ideas and collaborate with their classmates in real-time. In addition, 5G can be applied to provide students with remote access to laboratory equipment and simulations, allowing them to carry out experiments and engage in hands-on learning from a distance. Additionally, 5G can support the use of educational technologies such as Artificial Intelligence and Machine Learning, which can be used to provide students with personalized learning experiences based on their individual needs and abilities. As an example of how 5G is being used to enhance distance education around the world, Fisk University, located in Nashville, Tennessee, can be presented. Their new model of learning combines the in-person classroom experience with 5G-powered VR technology, enabling students to explore the complete skeletal structure, muscle structure, and the eleven human organ systems while still engaging in person with their classmates and instructors [71–73]. Thus, the 5G has the potential to significantly enhance the distance education experience for both students and teachers. With its increased speed and reliability, 5G can help create a more engaging and interactive learning environment and can support the use of various educational technologies.

3.5. Immersive Education, i.e., Virtual Reality, Augmented Reality, Mixed Reality, and Extended Reality

Immersive technologies, including Virtual Reality, Augmented Reality, Mixed Reality, and Extended Reality, are the latest solution to emerge in the world of distance education [74]. VR and XR provide us with experiences in a completely virtual world, while AR allows us to overlay computer-created content in the real world, and MR actively interacts with it [75–77]. In the case of XR, the users can actively interact through avatars [78]. They have the potential to revolutionize through 3D models the way students and instructors communicate and learn, providing new and innovative ways to engage with course material. They enable users to see 3D structures from various perspectives. It has been also shown that a correlation exists between the effectiveness of learning and the degree of immersion [79]. The application of immersive technologies requires the use of VR/AR/MR handsets, which entails significant costs, particularly MR equipment. On the other hand, considering high-cost lessons/workshops, such as autopsies in medicine, can lead even to significant cost savings [80,81].

VR-based simulators allow students to immerse themselves in virtual environments, providing hands-on experiences and simulations that are not possible with traditional classroom learning, see Figure 2 [82,83]. It is possible due to the fast feedback to learn [84]. For example, students can visit a virtual museum [85–87], explore a historical site [88], or

experience a simulated laboratory experiment [89]. This allows students to gain a deeper understanding of the subject matter and to develop their critical thinking and problem-solving skills. According to the educational environment in the field of exact sciences, solutions using Virtual Reality enable constructivist learning [90], while the ability to understand spatial information/data is crucial to conceptual issues [91]. Moreover, it contributes to the increase in learning outcomes, including the discovery of new scientific interests [92]. Other advantages are connected with the comfortable learning environment for students with disabilities, including the autism spectrum [93,94]. Recently, the Metaverse-based platform, which maximizes human engagement in the digital world, became more popular, for example, VoRtex, which is a supporting tool for virtual collaborative learning [95].

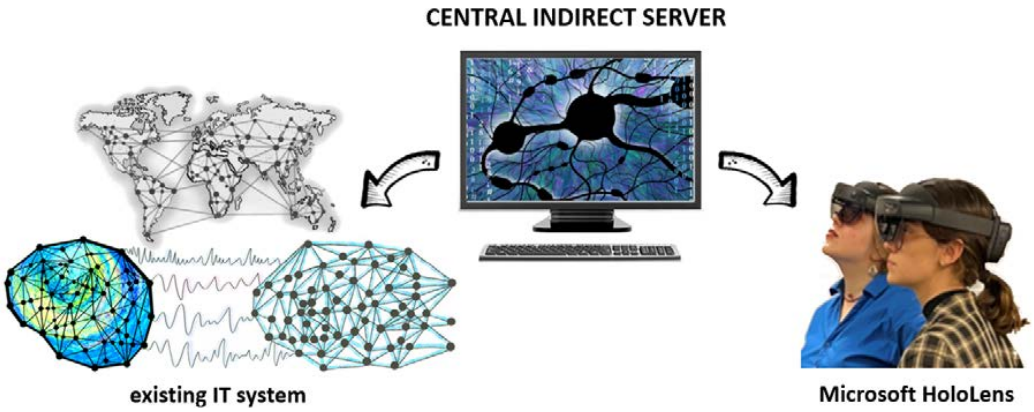

Figure 2. The scheme of the AR/MR-based education system.

Thus, AR technology overlays digital information onto the physical world, providing an interactive and immersive learning experience [96]. The additional computer-generated information placed into the surrounding world can be in the form of text, 3D graphics, video, and/or audio. This technology can be used in smartphones, tablets, or AR glasses. Two possibilities are available: marker-based or markerless [97]. In the case of the first one, the users need to point the camera at the marker, i.e., 2D image, 3D object, or QR code to display the AR content. This solution already has a wide application field taking into account educational aspects [98]. For example, students can use AR technology to explore a 3D model of a cell [99], see the inner workings of a machine, or interact with historical events. Additionally, in Science, Technology, Engineering, and Mathematics (STEM) education, AR-based solutions gain a lot of attention [100].

Recently, MR-based solutions also appeared in learning applications and more and more often for remote learning formulas [101]. It enables two-way voice communication, gesture control, and voice and eye movement control. The classes in the field of anatomy using the MR device HoloLens 2 are shown in Figure 3. In the case of an anatomical hologram of the human and its organs, students can learn anatomy in 3D [102]. An additional advantage of this approach is the possibility of active interaction with the hologram. In turn, in [103], the application of MR to medical chemistry courses was proposed. Users can view holograms of chemical structures at any time and location, and they can enlarge, reduce, and rotate them. This makes it easier for them to relate a complicated chemical formula to a real structure. The huge advantage of MR is the three-dimensional visualization of complex content. The MR-based solution in medical education saves time and costs in the case of practical activities such as autopsies. It also allows you to reconstruct the course of surgery and conduct targeted therapy without risking the lives and health of patients [104]. The MR-based approach is also used in STEM education, shipbuilding [105], and other engineering applications. Another application filed is connected with a Mixed-Reality game for training for police and uniformed services, including crime scene, battlefield, and accident simulators [106,107]. This makes it possible to train the novice staff together with the experienced ones while saving time and money and ensuring user safety.

Moreover, it is known that children were one of the groups most affected by social distancing during the COVID-19 pandemic. To make it easier for children to adapt to remote education, they were offered the use of an MR-based solution in the form of a game [108]. Thus, MR-based solutions can also promote socialization in the event of forced lockdowns.

Figure 3. Medical students during the MR-based anatomy courses with the application of the HoloLens 2, supported by the Erasmus + MR AME project [109].

By providing new and innovative ways to engage with course material, immersive technologies can enhance the distance education experience and help to overcome the isolation that is often associated with it [110]. It also introduces the learning processes as a bit of fun [111]. Another benefit of immersive technologies is that they can help to overcome the isolation that is often associated with distance education. With VR and AR, students can participate in virtual classrooms and interactive simulations, allowing them to collaborate and connect with their peers and instructors in real-time. However, it is important to consider the potential challenges and limitations, including cost and technical issues as well as health-related problems such as nausea, dizziness, sweating, pallor, and loss of balance [112], when using VR\AR\MR\XR in distance education. Another negative impact may be connected with redundant information, which may increase the workload of students and, as a consequence, provide the effectiveness of their understanding and remembering as well as the ability to use this knowledge in the future [113]. Additionally, emotional issues connected with the use of immersive technologies should be taken into account in designing and developing education systems [114,115].

Thus, depth perception is one of the most important roles of the XR; the systems should guarantee the rendering of several modalities, including vision, touch, and hearing, which is connected with the type of applied head-mounted displays, and their ability to devotion to depth [116]. It is connected with the perception of the user's movement and the evaluation of the user's traveled distance, which can be based on sensory information, including optic flow, proprioception, and vestibular feedback [117]. Moreover, it turned out that both real and virtual environments influence the evaluation of the distance in VR [118].

In distance education, XR-based technologies can provide students with immersive and engaging learning experiences, regardless of their location. For example, in medical education and training, AR and VR technologies can be used to ensure students with realistic and immersive simulations of clinical skills, procedures, and surgeries. This can help them develop practical skills and gain confidence in their abilities, even if they cannot be physically present in a clinical setting. It also reduces the costs of learning, e.g., autopsies, and increases their availability, and in the case of surgery simulators, it allows learning without endangering the lives and health of patients. In the field of engineering and architecture, AR and VR technologies can be used to provide students with virtual prototypes and simulations of products and designs, allowing them to learn and practice engineering skills from anywhere in the world.

Regarding the advantage of spatial learning, VR and AR technologies offer unique advantages for spatial learning in distance education. VR can create a fully immersive

environment that allows students to move and interact with objects in a virtual space, simulating real-world experiences. This can be especially useful for learning spatial skills such as navigation, spatial reasoning, and perception. AR, on the other hand, can overlay digital information onto the real world, providing students with additional context and information about their surroundings. This can be useful for tasks such as wayfinding, location-based learning, and remote assistance. Overall, the spatial component of VR and AR technologies can enhance the learning experience and provide unique advantages for certain types of learning and training in distance education.

3.6. Artificial Intelligence in Education (AIeD)

Recently, the application of Artificial Intelligence in various fields of life became a priority [119]. According to UNESCO-UNEVOC, 50 percent of organizations in the world report applications of AI in their actions [120]. Additionally, the Beijing Consensus urges the active use of humanity-oriented AI for the improvement of the teaching and learning processes. It is also following Sustainable Development Goals, in particular, SDG4 of the UNESCO 2030 Agenda [121]. AI is also increasingly being used in education to personalize learning [122], provide instant feedback, and facilitate communication between students and teachers [123]. For example, AI-powered tutors can provide customized lessons and assessments based on a student's progress and learning style. It also introduces the possibility of equalizing the chances of access to education in developing countries [124] and consequently counteracting social inequality. Thus, Artificial Intelligence is revolutionizing distance education by offering new opportunities for enhancing the learning experience. From personalized tutoring to automated grading, AI is providing a range of benefits for students and teachers alike. AI can also help identify those pieces of content that may be difficult for students to understand, and, consequently, the development of new methods to support student learning [125].

Personalized learning. AI algorithms can analyze students' data to identify strengths and weaknesses and then personalize learning content to match their needs. This allows for a more efficient and effective learning experience, as students receive tailored lessons and assessments that are aligned with their learning style and progress. Open Educational Resources (OERs) applied AI, for example, in the form of a Learning Referral Network to ensure a personalized curation of digital repositories [126]. The AI-based virtual assistant, including OS Siri, Microsoft Cortana, Amazon Alexa, and Google G-Assistant through voice recognition, process the questions and separate the answers [127]. Additionally, chatbots such as Digital Intelligence Virtual Assistants (DIVA) have been developed to answer students' questions [128]. In turn, in [129], a virtual agent provides students with information about the curriculum, schedule, teachers, and classroom location that has been presented. It is especially important, in the case of disabled persons, in particular visually impaired students [130].

Automated grading. AI-powered systems can automate the grading process, freeing up teachers' time for other tasks, such as providing personalized feedback to students [131,132]. Automated grading can also provide instant feedback to students, allowing them to make adjustments to their work and improve their performance. For example, the platform Chat-GPT (a huge language model designed to human-like text taking into account context [133]) can be applied to the grading of the student's essays [134].

Virtual tutoring. AI-powered virtual tutors can provide students with 24/7 access to learning support, making distance education more accessible for students with varying schedules [135]. These virtual tutors can also provide personalized lessons and assessments, making it easier for students to stay on track with their studies [136].

Improved accessibility. AI-powered tools can make distance education more accessible for students with disabilities [137] by offering features such as speech-to-text and text-to-speech. This can make distance education more inclusive, allowing students with disabilities to participate in online classes and access educational materials more easily.

Increased engagement. AI-powered systems can help to increase student engagement in distance education [138]. For example, chatbots can provide instant feedback and answer questions, gamification techniques can make learning more fun and interactive, and virtual reality can create immersive learning experiences. Another AI-based tool is Pedagogical Conversational Agents (CAs), which are playing the role of the teacher or peer learner based on knowledge gained through the analysis of student–teacher interactions in online forums and the grade book. The advantages of this solution are anonymity, the ability to connect at any time, and the ability to ask the same questions [139].

Thus, AI-based solutions are having a major impact on the field of distance education, offering new opportunities for enhancing the learning experience [140]. From personalized learning to increased engagement, AI is making distance education more accessible and effective for students and teachers alike. In [141], the combination of AI and the Internet of Behavior (IoB) to evaluate the factors, which affect students' motivation and achievements was presented. It turned out that this approach enables automated academic progress tracking. AI can also be applied to AI-powered Education Management Information Systems (EMIS), which enable data collection, analysis, and dissemination to effectively manage science [142]. As technology continues to advance, we will likely see even more exciting developments in the use of AI in distance education in the years to come [143].

3.7. Cloud-Based Platforms

Cloud-based platforms, including Google Classroom and Microsoft Teams, allow teachers to store, share, and collaborate on educational materials with students, regardless of their location. It hosts the server and operating system in the web-based data center at a large scale. It provides paid access to various types of computing services, databases, servers, analyses, and software. It also allows you to use services such as storage and network as part of a user's subscription. The cloud-based platform offers also cost savings [144]. This makes distance education more accessible and convenient for students. With the rise of remote learning, these platforms provide an accessible and convenient solution for delivering education to students all over the world. This approach offers many positive aspects.

Accessibility. With cloud-based platforms, students and teachers can access course materials and learning tools from anywhere with an Internet connection [145]. This makes it easy for students to continue their education, even if they are unable to physically attend classes.

Collaboration. Cloud-based platforms often include collaboration tools that allow students and teachers to work together on projects, share files, and communicate in real-time [146]. This enhances the learning experience and helps foster a sense of community among students.

Flexibility. One of the main advantages of distance education is the flexibility it offers. With cloud-based platforms, students can work at their own pace and schedule. This allows them to balance their education with work and other responsibilities.

Cost-effective. Cloud-based platforms are generally more cost-effective than traditional educational methods, as they do not require expensive hardware or software. This makes it easier for schools to offer distance education programs to more students, regardless of their financial situation [147].

Scalability. As the demand for distance education continues to grow, cloud-based platforms can easily scale to accommodate large numbers of students [148]. This ensures that students receive a high-quality education, even if the number of students enrolled in a course increases dramatically.

Cloud-based platforms have transformed the field of distance education by providing an accessible, flexible, and cost-effective solution for delivering education to students all over the world, which contributed to access to education, particularly in developing countries [149]. Since the smartphone is under continuous development, cloud-based mobile learning (CBML) provides an interesting alternative to e-learning and m-learning [150,151].

The disadvantage of such a solution in distance education is the fact that in many countries, especially in developing countries, there is a large group of students who cannot afford the fees. Special fundraisers have been set up to fund such access [152].

3.8. Learning Management Systems

Learning Management Systems are digital platforms that provide a centralized location for the delivery and management of educational content and activities [153]. These platforms provide a centralized location for course materials, assignments, assessments, and communication between students and teachers [154]. They have become increasingly popular in recent years due to the rise of e-learning and the increasing demand for flexible, accessible, and cost-effective education [155]. The most commonly used LMS solutions include Blackboard [156], Canvas [157], and Moodle [158]. The first one enables curse management, which is integrated with authentication protocols and student data. The second one is an online environment that allows you to create graphic designs, while the third one is a remote learning environment via ICT networks, available through a web browser. Here are some of the key benefits of using an LMS in education, in particular, the remote learning formula [159].

Convenience. With an LMS, teachers, and students can access course materials and educational resources from anywhere with an Internet connection. This eliminates the need for physical textbooks, lectures, and other materials, and makes learning more convenient and accessible.

Increased engagement. LMS platforms often include interactive elements, such as quizzes, discussions, and multimedia presentations, which can help engage students and keep them interested in the course material.

Improved assessment. LMS platforms provide teachers with a variety of tools for assessing student performance, including online exams, quizzes, and other assessments. This helps teachers to track student progress and provides students with immediate feedback on their performance.

Increased collaboration. Many LMS platforms include collaboration tools, such as discussion forums and group projects, which allow students to work together and share ideas. This fosters a sense of community and encourages students to support one another in their learning journey.

Easy tracking and reporting. LMS platforms provide teachers with a centralized location for tracking student progress and performance. This allows teachers to quickly and easily see how each student is progressing and make adjustments to their teaching approach as needed.

Learning Management Systems are an essential tool for modern education. With their many benefits, including convenience, increased engagement, improved assessment, increased collaboration, and easy tracking and reporting, they offer a powerful solution for delivering and managing educational content and activities. Whether you are a teacher, student, or school administrator, an LMS can help improve the quality of education and make learning more accessible and effective.

3.9. Video Conferencing Tools

Video conferencing tools, such as Zoom [160], Amazon Chime [161], BlueJeans Meetings [162], Google Hangouts Meet [163], Microsoft Teams [164], WebEx Meetings [165], and Skype [166], allow students and teachers to connect in real-time, regardless of their location [167]. This technology has made it easier for distance education programs to incorporate live lectures and discussions into their curriculum. Since it is based on web cameras, chats, microphones, and other IT tools, it enables verbal and non-verbal communication [168]. Video conferencing tools have become increasingly important in the field of learning, providing students and teachers with a convenient and effective way to communicate and collaborate remotely [169]. Here are some of the key benefits of using video conferencing tools in distance education.

Real-time interaction. Video conferencing tools allow students and teachers to communicate and interact in real-time, just as they would in a physical classroom [170]. This enhances the learning experience and helps foster a sense of community among students.

Accessibility. With video conferencing tools, students and teachers can participate in virtual classes from anywhere with an Internet connection. This eliminates the need for physical classrooms and makes education more accessible to students in remote or underserved areas [171].

Improved engagement. Video conferencing tools often include features such as screen sharing, virtual whiteboards, and real-time collaboration, which can help keep students engaged and interested in the course material [172,173].

Cost-effective. VCTs are often more cost-effective than traditional methods of delivering education, as they eliminate the need for travel, physical classrooms, and other expenses. This makes it easier for schools to offer distance education programs to more students, regardless of their financial situation [174]. Moreover, these technologies promote sustainable development, prevent social exclusion, and also help to reduce the carbon footprint

Increased flexibility. Video conferencing tools allow students and teachers to participate in virtual classes on their schedules. This provides students with greater flexibility and makes it easier for them to balance their education with work and other responsibilities [175].

Video conferencing tools have become a vital tool for distance education, providing students and teachers with a convenient and effective way to communicate and collaborate. With their many benefits, including real-time interaction, accessibility, improved engagement, cost-effectiveness, and increased flexibility, they are well worth exploring for anyone involved in distance education. The comparison of the leading video conferencing tools is listed in Table 2.

Table 2. Comparison of the commonly used video conferencing tools.

VCTs	Participants	Price	Advantages	Disadvantages
Amazon Chime [161]	Up to 100	$3.00 per day pro 1 user $15.00 per month pro 1 user	Compatible with SIP/H.323 equipment High-quality video Wideband audio	Share screen on mobile devices is unavailable
BlueJeans Meetings [162]	100 150 Up to 200	$9.99 per mount (5 h of recording) $12.49 per mount (25 h of recording) $16.65 per mount (unlimited recording)	High-quality audio Compatible with SIP/H.323 equipment Facebook Live integration	No file sharing
Google Hangouts Meet [163]	25 100	$6.00 basic per mouth $12.00 business per mouth	Compatible with SIP/H.323 equipment Live stream up to 100,000 participants Google Drive	Share screen on mobile devices is unavailable

Table 2. *Cont.*

VCTs	Participants	Price	Advantages	Disadvantages
Microsoft Teams [164]	100 300 300 300	Free $3.40 per mouth $5.10 per month (basic Office packed included) $10.50 per month (Office packed included), Webinar hosting	Live stream up to 10,000 participants Compatible with SIP/H.323 equipment	Meeting scheduling and recording are limited due to fees
WebEx Meetings [165]	100 150 200 1000	Free (meeting length up to 40 min) $13.50 per month (meeting length up to 24 h) $19.00 per month (meeting length up to 24 h) to negotiate (meeting length up to 24 h)	High-quality video Wideband audio Automatic MP4 recording of the meeting Facebook Live integration Webinar hosting up to 100,000 participants Compatible with SIP/H.323 equipment	Free version limited to 40 min
Zoom [166]	100 100 300 1000	Free (meeting length up to 40 min) $149.90 (meeting length up to 30 h) $199.90 (meeting length up to 30 h) to negotiate (meeting length up to 30 h)	Webinar hosting up to 100,000 participants Compatible with SIP/H.323 equipment	Free version limited to 40 min

3.10. Big Data

Big Data technology has the potential to revolutionize the field of distance education, providing teachers and administrators with valuable insights into student behavior, performance, and preferences [176]. It includes data collection as well as providing access to resources, infrastructure, data processing, and mining. Thus, the huge amount of data required adequate management tools [177,178]. Here, we concentrate mainly on the advantages of Big Data in the context of distance education [179].

Personalized learning. Big Data can be used to analyze student behavior and performance, allowing teachers to personalize their instruction to better meet the needs of each student [180]. This can lead to increased engagement and improved student outcomes.

Improved assessment. The proposed approach can be used to track student progress and performance, providing teachers with valuable insights into which educational strategies are working and which are not. This allows teachers to make data-driven decisions about how best to support student learning.

Better resource allocation. Big Data can be adapted to analyze student behavior and preferences and contribute to helping teachers and administrators to make more adequate decisions concerning resource allocation. For example, if data shows that a particular type of resource is particularly popular among students, more resources can be allocated in that area [181].

Better decision-making. Big Data can provide teachers and administrators with valuable insights into student behavior, allowing them to make data-driven decisions about the direction of their programs and initiatives [182]. This can help improve the overall quality of education and make distance education more effective and efficient.

Increased efficiency. Big Data can be used to streamline administrative processes, such as course scheduling, student registration, and record keeping [183,184]. This can save time and resources, freeing up more time for teachers to focus on instruction and student support.

Exploring the application of Big Data in distance education programs can help achieve better outcomes and improve the overall quality of education for both students and teachers/lecturers.

3.11. Blockchain

Blockchain technology, namely distributed ledger technology (DLT) [185], has the potential to revolutionize the way we approach distance education. It enables, among others, the storage of transactions and records them securely. This approach can create a secure, decentralized platform for online learning that can offer numerous benefits to both students and institutions [186]. For example, it allows you to create a set of micro-credentials that confirm a person's academic achievements. Let us consider the advantages that can come from the use of blockchain technology in the remote learning formula.

Secure Record Keeping. Blockchain technology provides a secure and tamper-proof record of student achievements and accomplishments. This ensures that records cannot be lost, altered, or corrupted and gives students a permanent and accessible record of their education. In [187], the blockchain-based micro-credential for higher education EduCTX was shown. The solution enables not only the collection of academic data but also the transformation of it into a global format.

Decentralized Platform. Blockchain eliminates the need for a central authority to manage student records and academic credentials. Instead, a decentralized platform allows for secure and transparent management of student data. It provides also the management systems of educational certificates and delivers a credentialing e-Portfolio [188]. Moreover, the ensured control helps to avoid counterfeiting. In turn, in [189], the decentralized approach based on the blockchain provides the opportunity to plan career paths.

Verifiable Credentials. Blockchain technology can help to eliminate the potential for fraud by allowing students to easily verify their academic credentials, while it is based on the public key (pseudonym) [190]. Even when a record is revealed, the true identity of the owner remains unknown. This helps institutions to quickly and easily verify the credentials of their students and also their safety [191].

Enhanced Accessibility. Blockchain-based distance education platforms can provide enhanced accessibility to educational resources and opportunities, regardless of location or economic status. This can help to break down barriers to education and increase the number of students who can participate in distance learning programs [192]. Storing job offers on the Ethereum Blockchain enables their effective matching to the user (student).

Improved Collaboration. Blockchain technology can facilitate improved collaboration between students and institutions by providing a secure platform for shared data and information. This can lead to enhanced learning experiences and improved outcomes for students [193].

Thus, blockchain has the potential to revolutionize the way we approach distance education by providing a secure, decentralized platform for online learning [194]. This technology can help to eliminate barriers to education, improve collaboration, and provide

students with verifiable academic credentials. As such, it has the potential to play a significant role in shaping the future of distance education.

4. Discussion and Conclusions

The application of new technologies in distance education has revolutionized the way students and teachers/instructors communicate and learn. It enables breaking down geographical barriers and providing access to education for people all over the world, even from hard-to-reach areas. From laptops and tablets to Virtual Reality headsets and digital whiteboards, these technologies have greatly enhanced the learning experience and made it easier for students to collaborate and engage with course material. However, it is also important to consider the potential challenges and limitations, including necessary financial outlay, particularly in developing countries. The cost of hardware and software, especially taking into account the price of MR devices and Internet access, can be prohibitively high for some, making it difficult for them to participate in distance education programs. In fact, according to Statista about 63.1 percent of the global population are users of the Internet, and 59.0 percent of them use social media, in particular Facebook (core platform), WhatsApp, Facebook Messenger, and Instagram [195]. China, India, and the United States have a higher number of Internet users than other countries, while the smallest number of Internet users is in Oceania and the Caribbean [196]. On the other hand, it has been also estimated that about 37 percent of the global population has never had access to the Internet [197]. Common to all regions of the world is the generational gap in the use of the Internet. An average of 71.0 percent of the global population between the age range of 15–24 uses the Internet, in comparison to 57.0 percent in other ranges. Taking into account the least developed countries, only 34.0 percent of young people have access to the Internet. A key barrier is linked to the affordability of broadband devices and services. The forecast assumed that by 2028, the number of Internet users should rise by about 21.3 percent. This contributes to the increasing opportunities for access to remote education.

Another issue is the fact that new technologies can also bring with them technical challenges, such as compatibility issues, slow Internet speeds or unstable Internet connections, and software glitches, as well as a lack of devices [198]. The highest average speed of the Internet is denoted in Taiwan, i.e., 85.02 MBPS, while the lowest is in Yemen (0.38 MBPS) [199]. Among the countries with the slowest broadband access, 12 are in the Arab states, 10 are in the Asia–Pacific region, and 3 are in Latin America. These can disrupt the learning experience and make it difficult for students to participate effectively in distance education programs. It can also contribute to inequality in access to education, in general.

Thus, the beginning of COVID-19 showed significant difficulties for students with access to the Internet and personal electronic devices, especially in developing countries [200]. Additionally, teachers often reported technical problems with remote learning [22]. The commonly used conduct classes were MS Teams, Google G platforms Suite, Zoom, Skype, and Smart Class [21]. The scientific community also used educational platforms such as Intranet and Moodle [201], as well as social media, including Twitter, YouTube, WhatsApp, Instagram, and Facebook [202]. Thus, the majority of users believe that video conferencing is no worse than traditional classes [203]. It should be also mentioned that some users found the Google Classroom UI boring. An additional problem was difficulties in sending private messages between students due to connectivity problems [204]. Immersive technologies have a huge potential to revolutionize distance education by overcoming the shortcomings of two-dimensional Internet learning systems [205]. On the other hand, the security of distance education network nodes is also important. Here, the Machine Learning approach has great potential [1].

Thus, the COVID-19 pandemic was a huge worldwide test for remote learning, paying attention to the aspect of lacking personal contacts [206]. Moreover, students that lack personal contacts contribute to a lack of concentration and motivation as well as time management difficulties [207]. The COVID-19 pandemic has shown that teachers and

students are tired of virtual meetings [208]. However, a distinction should be made between conscious distance learning and circumstance-induced distance learning. Distance education can also be isolating for some students, with the lack of face-to-face interaction and social interaction with peers and instructors. This can contribute to a decrease in student motivation and engagement and make it more difficult for students to feel connected and engaged with the course material. Student's parents also often reported problems with remote learning [209]. As significant disadvantages, parents also indicated the stress associated with learning online and the additional financial outlays associated with it [210]. It should also be pointed out that the sudden necessity to temporarily switch to the remote learning formula, i.e., emergency remote teaching (ERT), is not the same as modern distance learning [211].

There are also concerns about equity and access to new technologies, with some students and instructors having more access and resources than others. This can create an unequal playing field and make it more difficult for some students to participate and succeed in distance education programs. An interesting analysis based on Recurrent Neural Networks (RNN) algorithms of over 160,000 tweets regarding the transition to remote learning in connection with the COVID-19 pandemic was shown in [212]. It turned out that about 54.4 percent of tweets have a negative overtone. Moreover, teachers pointed out that the involvement, activity regularity, and quality of students' work are higher in the case of the traditional teaching formula. However, the remote teaching formula allowed them to save a lot of time [211].

The introduction of new technologies for the study of different fields of knowledge will require consideration of the specific needs and requirements of each discipline. In the humanities, new technologies can be used to support research and analysis of texts, historical documents, and other cultural artifacts. For example, digital archives and databases can provide access to a vast range of materials, while tools such as text analysis software can help students identify patterns and themes in complex texts. For fields such as literature, history, and philosophy, new technologies can support research, collaboration, and creativity. Technologies such as online databases, virtual archives, and digital publishing tools can help students and researchers access and analyze primary sources, collaborate with peers, and share their work with a wider audience. In the fields of science, technology, engineering, and mathematics (STEM), new technologies can be used to support the development of problem-solving skills and facilitate interactive learning. For example, virtual math labs and simulations can provide opportunities for students to experiment with concepts and explore mathematical relationships more visually and intuitively. New technologies in academics can also be used to support data analysis, visualization, and collaboration. For example, scientific visualization tools can help students to better understand complex scientific concepts, while online collaboration platforms can facilitate communication and knowledge sharing among students and researchers. In turn, in business and management studies, new technologies can be used to support data-driven decision making and analysis. For example, business analytics tools can help students to analyze large data sets and develop strategies for improving organizational performance. For fields such as psychology and sociology, new technologies can support data collection, analysis, and visualization. Technologies such as survey tools, statistical software, and data visualization platforms can help students to design and conduct research studies, analyze data, and communicate their findings effectively. In the arts, new technologies can be used to support the development of creative skills and facilitate collaboration. For example, digital tools and platforms can be used to create and share multimedia projects, while virtual reality and augmented reality technologies can provide new opportunities for immersive and interactive art experiences. The introduction of new technologies in distance education for the study of medicine has brought about several key features that have transformed the way medical education is delivered. New technologies such as virtual reality, simulations, and video conferencing tools have made it possible to create more interactive and engaging learning experiences. Students can now participate in virtual patient simulations,

collaborate with peers in online discussion forums, and attend live webinars with expert medical professionals. Distance education is often more cost effective than traditional classroom-based learning, as it eliminates the need for students to travel to campus, pay for accommodation, or purchase expensive textbooks. Distance education has also opened up a world of learning resources to medical students, including online libraries, databases, and video lectures from leading medical professionals. This makes it easier for students to access the latest research and knowledge in their field of study. New technologies such as VR and AR provide immersive learning experiences that can transport students to virtual environments and scenarios. This can help them develop clinical skills, practice procedures, and experience medical conditions in a realistic and controlled setting. These technologies allow students to interact with virtual objects and simulations, making the learning experience more engaging and interactive. This can help them retain information better and apply it to real-world scenarios. VR and AR technologies provide a safe and risk-free learning environment where students can practice procedures and clinical skills without the risk of harming real patients. This can help students develop confidence and competence in their clinical skills before working with real patients. New technologies can connect students with remote experts, allowing them to observe and learn from medical procedures and surgeries in real time. This can help students gain exposure to a wider range of medical conditions and procedures, regardless of their physical location. VR and AR technologies can be a cost-effective way to deliver medical education, as they eliminate the need for expensive physical models or simulators. They can also reduce the need for travel and in-person training, which can save time and money. Overall, the introduction of VR and AR technologies in distance education for the study of medicine can help students develop clinical skills, gain exposure to a wider range of medical conditions, and improve their confidence and competence in their field of study.

On the other hand, it turned out that the academic teacher in the fields of STEM have much less problem with using emerging technologies in teaching than their counterparts in the humanities, although the latter did not use them in such an advanced formula as the former [213]. Thus, the application of emerging technologies is more effective in the STEM area. Another advantage of the application of emerging technologies in the COVID-19 pandemic was the fact that they also help maintain academic unity during lockdown times [214]. The features of introducing new technologies for the study of different fields of knowledge will depend on the specific needs and objectives of each discipline. By selecting and implementing technologies that are well suited to the unique challenges and opportunities of each field, educators can enhance learning outcomes and prepare students for success in their chosen careers.

While new technologies can enhance the learning experience, there are also concerns about the quality of education in distance education programs. The quality of education in distance education programs is also a concern, with some educators arguing that the lack of personal interaction and feedback can negatively impact student outcomes. In turn, in [205], it has been shown that teachers can support students through personalized written feedback. On the other hand, the development of interactive content also requires technical skills and knowledge of technology. This requires teachers to invest a lot of time in the form of mastering the technology, reacting quickly to students' feedback, and updating the content of interactive courses. An interesting observation during the pandemic was that science students and teachers attached more importance to the lack of technical skills than their humanities counterparts [215].

According to the study [216], females demonstrated higher tiredness with distance learning and the lack of personal contact, while there are no significant differences between students with and without disabilities. Another interesting finding was that satisfaction with distance learning depends on self-perception [217]. Participants with higher self-esteem showed greater satisfaction with the remote learning formula. This clearly shows the necessity to carry out activities aimed at raising the self-esteem of remote education

participants. Other research shows that older students cope better with the formula imposed by the COVID-19 pandemic than students in the first grades [218].

In fact, the return to face-to-face teaching after a period of remote or online learning can be greatly enhanced by the application of emerging technologies. These technologies can offer a range of benefits that can make the transition smoother and more effective. One of the most significant benefits of emerging technologies is the ability to create a hybrid learning environment. This means that students can attend classes in person but also have access to online resources and tools. This can help students to review materials at their own pace, catch up on missed classes, or access additional support. It can also support teachers in providing more individualized attention to students and facilitate better communication. Besides, emerging technologies give opportunities for active learning, where students are engaged in the learning process and encouraged to participate. This can be achieved through the use of gamification, virtual reality, and other interactive technologies. These tools can help to make learning more engaging and fun, which can help to improve student motivation and performance. Emerging technologies can be used to personalize the learning experience for individual students. This can be achieved through the use of adaptive learning technologies that adjust to the student's level and pace of learning. This can help students to learn at their own pace and improve their understanding of complex concepts. New technologies can provide teachers with new ways to assess student learning. This can be achieved through the use of online quizzes and assessments, which can provide immediate feedback and help teachers to identify areas where students may be struggling. This can help teachers to adjust their teaching approach and provide additional support where needed.

Overall, the application of emerging technologies can greatly benefit the return to face-to-face teaching. These technologies can provide new opportunities for learning, engagement, and assessment, which can help to improve student performance and make the learning experience more enjoyable and effective. While distance education has many benefits, several potential drawbacks should be considered. One of the biggest drawbacks of distance education is the lack of face-to-face interaction with instructors and other students. This can lead to a sense of isolation and make it difficult to obtain the support and guidance needed to succeed. Remote learning often relies heavily on technology, and technical issues can be a major challenge. Technical problems with online platforms or Internet connectivity can disrupt learning and cause frustration for students. Thus, distance education requires a high level of self-motivation and discipline. Students must be able to manage their time effectively, stay on top of assignments, and maintain their focus without the structure of a traditional classroom environment. On the other hand, remote learning programs may have limited access to resources such as libraries, laboratories, and specialized equipment. This can limit the scope of their learning and affect their ability to fully participate in certain courses. In turn, networking is an important part of the educational experience, and distance education can limit opportunities for students to network and build relationships with peers and instructors. Feedback is also essential for learning and growth, and distance education may provide limited opportunities for students to receive feedback from instructors and peers. Distance education can be a great option for many students, but it also has its challenges. The return to face-to-face teaching will certainly be important from the point of view of the disadvantages of distance learning, especially for young children, where face-to-face interaction with the teacher and other children is crucial for children's development. It is important to carefully consider these drawbacks and determine whether distance education is the right choice for your educational goals and learning style.

To summarize, while new technologies have greatly enhanced the distance education experience, it is important to consider the challenges and limitations they can bring. Ensuring access and equity to new technologies and addressing the technical and pedagogical challenges will be crucial for ensuring the success of distance education programs. Moving forward, it will be important for educators and institutions to strike a balance between

leveraging the benefits of new technologies while also addressing the potential challenges and limitations they bring.

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