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The Significant and Challenges of Extended Reality Technologies in Learning and Training during Covid-19 Pandemic

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Abstract:
Extended Reality (XR) technologies can play a significant role in proving huge value to education following the changed circumstances universities faced during pandemic. This study presents Virtual Reality (VR) as a means of enhancing learning in education and training field during outbreak. This paper represents the use of XR technologies in a wide variety of settings, including the context of the education, learning, and training. Considering the most significant papers with a total of 2,270 articles from conferences and journals were obtained through online search was conducted from databases such as Google Scholar, Scopus, Web of Science (WoS), IEEE Xplore, ACM Digital Library, Springer Link, Research Gate, and Academia. The number of papers released, and the number of references obtained in both databases have a substantial-high influence. Researchers performing literature searches using bibliographic databases as their initial and dominant resource to customized and filtered sort out the most relevant publications examined based on abstract and key words such as Extended reality, Virtual reality, VR training, COVID-19, Distance education, Virtual environments, Education, Virtual Laboratories. According to the findings, XR equips students to gain professional skills to their subject as well as to increase the performance of learning quality and improve training.

Keywords: Extended reality; Virtual reality; COVID-19; Distance education; Virtual learning environments; Human-computer interaction

1. Introduction

Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) are three of the Extended Reality (XR) technologies being used in a wide variety of fields including design, engineering, education, and training. In consequence, the possibility for successful learning transfer is increased when students can practice what they learned in a similar environment to where the abilities will be employed [1]. The learning environment can be improved through the integration of educational technology via various digital resources. Consequently, the pandemic has highlighted the necessity for the transformation of distance learning and opened up new opportunities for immersive virtual exchanges.

Since the virus varies over time, the Covid-19 virus and vaccine hesitancy are currently among the most serious worldwide concerns. Variants that pose a greater risk to global public health, including Mu, Alpha, Beta, Delta, Gamma and Omicron, are known as variants circulating in the world of concern and may be more resistant to vaccines. Hence, the closing of institutions and universities at all levels of the educational system was one of the initial actions employed to slow its growth. Based on UNESCO records, 166 nations had shuttered their schools and institutions as of March 30, 2020. These policies impacted 87% of the student population worldwide or around 1,520 million pupils. Moreover, around 63 million educators throughout the globe have stopped teaching in classrooms.

The pandemic has made it impossible for students to be exposed to each other and keep social distance because of the health hazard. When their academic pursuits were abruptly and unexpectedly halted, educational systems throughout the globe resorted to online technology to resume their learning. In fact, XR technologies bridge the gap between individuals, information, and experiences, allowing individuals to connect in new ways through fully immersive experiences. Correspondingly, XR is a catch-all word that encompasses all immersive technologies, including VR, AR, and MR. Immersive technologies combine the real and virtual worlds or create a completely immersive experience.

As a result, VR technology may be an excellent tool for developing alternatives that emphasize knowledge acquisition and academic accomplishment [2]. Therefore, immersive environments can transform learning and teaching through the application of XR in training and educational settings. In the same way, the incorporation of XR into classrooms and training sessions can provide students and trainees with more relevant learning and training experiences by increasing their motivation. Furthermore, XR is used in the classroom to illustrate complex concepts, simulations, and scenarios. There are numerous applications of XR in professional training that help users solve problems and respond to dangerous situations without endangering themselves or others. In summary, immersive learning in surroundings is possible using XR technology, which is potentially used as a learning and training platform in higher education to achieve a high rate of success. As shown in Table 1, XR technologies can be applied in both educational and training processes in education and industry field.

Table 1. Extended reality technologies in stages of learning and training

Type of Simulation	Factors	Reference
Virtual lab experiment, game-based learning features	Experimental design, communication, collaboration, usability, enjoyment, reflective thinking	[3], [4]
Virtual environment	Instructional models, effectiveness, benefits, and challenges	[5]
Virtual learning environment	Cognitive training, Industry 4.0, maintenance, and emergency training	[6]
VR input and display devices	Contributions of the five human senses	[7]
VR for industrial training	Industrial training tool, repair and maintenance, novel approach, workforce	[8]
VR learning technology-enhanced learning	Industrial robotic arms for engineering, enhanced learning, manufacture	[9], [10]

1.1 Background

Nowadays, engineering students have significant problems in providing all learners with essential and substantial practical experience. Studies indicate that traditional learning techniques produce a disparity between real-life circumstances and training, for instance, industry injuries, which is approximately 35% from poor training [11]. There are several challenges in students training as well as limited resources, space, and occupational safety (OSH) [12]. As a matter of fact, VR technology bridges the gap between teachers and students. The unique feature is that it enables learners to practice in various industry scenarios with a realistic environment by enabling students to be more informed when faced with similar situations in the workplace. Today, new digital technology has been used to enhance the learning process [13–15].

VR is based on the idea of immersing a participant in a virtual world in real-time. It can be experienced in a variety of ways, but it is most utilized with head-mounted displays (HMD), which provide a virtual world while allowing users freedom of movement [16]. Thus, realistic environments allow for scenarios and experiments that could be impossible or hazardous in the actual world. VR technology provides students with an active role in education and training during the pandemic [17]. As a result, the goal of the present study is to investigate and analyze scholarly papers on the problems and relevance of XR technologies in education, learning, and training amid the Covid-19 pandemic to continue the educational process successfully. In this research, the paper is organized into several sections. Initially, we present the methods and search strategy, besides data collection. Furthermore, data analysis and presentation of key findings as

summarized results to achieve the research objectives. In addition, we will list and discuss the challenges and future work to make VR technology possible in the education and training sector to continue educational process.

2. Materials and Methods

The researcher has to rethink various aspects of future directions in education during the pandemic to achieve powerful technology transformations. A bibliometric analysis was conducted to present a general approach to documenting research related to the impact of COVID-19 on educational and training outcomes for university students. These bibliometric indicators are tools used to measure scientific production and to analyse the impact of scientific work. Furthermore, they allow researchers to track the evolution of interest in the subject matter under study by reflecting the most relevant journals and keywords in recent years.

In this research, we have focused on papers since 2019 occurred because XR research indicates in education, learning, and training activities expanded greatly during the pandemic. We present the results from bibliometric analysis by employing software tools uses Dimensions data and solutions for discovery and analytics from (https://www.dimensions.ai/) to analyze scientific literature. The reason is providing a fresh take on research information and comprehensive data that empowered users to explore connections between a wide ranges of research data. Software tools were used during the process by using this methodology, one can identify, organize, and analyse the main components of a specific research area. The underlying concept and main purpose were to discover the challenges and importance of how to use XR technology to better understand in education, learning, and training during the pandemic.

2.1 Data collection

In this investigation, the authors utilized the Web of Science (WoS) and Scopus databases to gather all relevant papers (Figure 1) from diverse classified scholarly papers issued in English as part of our data collection. A brief study was chosen to perform the search, considering its relevance in indexing computer science works and related areas. the authors searched publications in Scopus databases such as Google Scholar, PubMed, IEEEXplore, Web of Science, Academia, Science Direct, ACM Digital Library, and Research Gate since the size of the combined database was substantial.

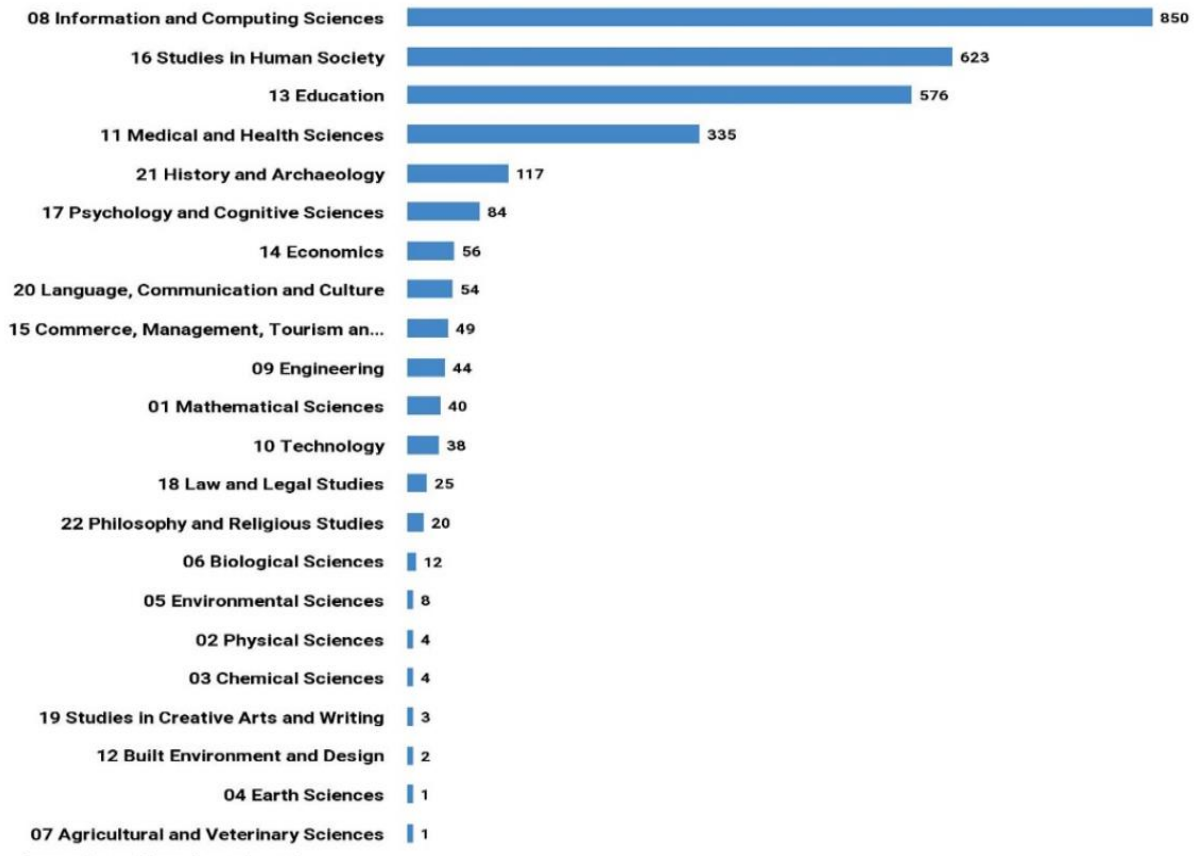

Figure 1. Number of papers that involve classification of Scopus publications in each research category

An analysis of the scientific literature was performed from database. This contains extensive coverage reaching approximately 2,270 articles covering conferences and journals research period from 2019 to the end of 2021 were included in this collection. In this context, it is worthwhile to consider identification of scientific products is important because the authors can examine the effects of the epidemic on education and physical environments at universities.

This research builds on existing knowledge in the fields of use XR during the pandemic is accomplished by employing keywords such as Keyword given by VR, Teaching and Learning, Virtual Environments, Distance Education, Covid-19, Training, Extended Reality. The title, abstract, and keyword fields are all included in this research. On the other side, it has been explored to expand the Index Terms area with data from own or external thesaurus. The time of temporary coverage considered coincides with the commencement of the condition as of December 2019. These publications were checked in the original databases to ensure that legitimate entries were not discounted, where the remaining incomplete entries were removed.

As shown in Figure 1, the number of publications and deeper understanding of the process of each research category such as 08 Information and computer sciences, 16 studies in human society, 13 education, 1303 specialist studies in education, 0801 Artificial Intelligence and image processing, 0806 Information Systems, as well as 11 Medical and Health Sciences. The search fields illustrate this procedure by being chosen for their highest descriptive value and representativeness of each record, such as: the year of publication, journal, subject area, as well as the country of affiliation and the keywords that define the article.

2.2 Data analysis

A review of the scientific literature was conducted to propose a standard approach to document investigation on Covid-19's impacts in university such as learning, teaching, and training contexts. The goal of this technique is to discover, classify, and evaluate the major components of a certain study subject. The authors illustrate this procedure by using the bibliometric indicators discovered are methods for assessing scientific outputs and examining the effect of scientific research. In this context, it is worthwhile to consider and displaying the most prominent authors, journals, countries, and keywords shows how interest in the subject matter has grown. Consequently, its use is predicated on the essential role that periodically serves in the spread of new information.

3. Results and Discussion

Nowadays, collaborative learning is increasingly popular in the educational field, where teachers and students participate actively in the educational process. With the pandemic, teachers and students are physically separate, and collaborative learning happens exclusively through Information Communication Technology (ICTs). The physical distance between teachers and students creates a space for misunderstanding. To deal with it, teachers must explore the ICTs to foster mechanisms to motivate and aggregate the students, developing an environment of trust, respect, and empathy without losing the educational objective. Even though teachers may bring to the virtual environment their expertise developed through their professional life, where different learning spaces have different characteristics that must be respected.

In this respect, it is necessary to highlight learning and training techniques must be adaptable and has a positive effect in new technologies for future generations. As a consequence, taken advantage through dynamic and interactive content development education. As Figure. 2 shows, the number of scientific articles containing the keywords Extended reality, Training, COVID-19, Distance Education, Virtual Environments, Teaching and Learning, VR keeps growing every year. However, the visualization shows the number of scientific papers published mainly between 2019 and 2021. The total number of publications in 2019 was 1, while in 2020 were gradually increased during a period of rapid change and growth of research to 663 articles. Consequently, it can be seen in Figure 2 analysis in 2021 research published considerable 1,606 articles. Admittedly, the rapid increase of published scientific papers indicates the opportunities technologies at the present.

The results of this study are presented in five sections, with each section's results and details outlined. The authors conclude with a discussion and conclusion on the main challenges to implementing XR in the training and education area. Additionally, the researchers present XR technologies in stages that demonstrate simulated reality and the use of interactive tools in training, education, teaching and learning.

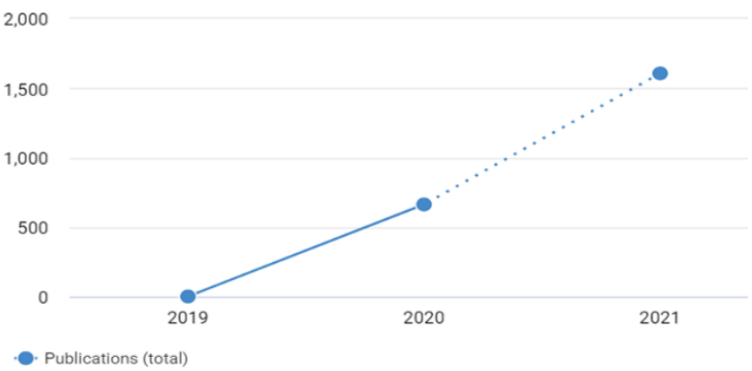

Figure 2. Chart of papers shows the number of publications. Data from https://app.dimensions.ai/

3.1 Virtual reality in human education

Today, graduates' students must have fundamental and professional knowledge. In this regard, the processes of informatization of education are accompanied by the search for new methods of organizing the educational process, focused on self-development and self-organization of the person. The use of VR to generate realistic experiences that would be impossible or dangerous to experience in the actual world. Hence, VR training is similar to learning in that it includes the repetition and repetition of scenarios that help with the development of practical skills such as cognitive load, visual attention, and training evaluation [18].

Immersive Virtual Reality (IVR) outperforms non-immersive learning methods in the form of better learning, and 3D VR is far more engaging than conventional ways. Although VR has the power to transform education, it has yet to be extensively used in traditional classrooms due to the rising cost of headsets. Currently, VR has now become a part of education as a creative tool for learning, especially as school or universities shifts to online systems and digital environment. VR in education makes learning more enjoyable, safe, and attractive.

Recently, research indicated by the University of Warwick, learners were able to retain study resources more in the form of VR headsets than in textbooks, lectures, and videos. Research suggests that VR allows learners to earned experience in complex worlds they would not encounter in real training. Thus, it may appear beneficial to many careers. For example, VR is widely recognized as a potential technique for training emergency first responders and other safety-sensitive personnel. It is the only method that allows students to be immersed in virtual space that would be too dangerous in real-life.

In reality, the majority of firms wanting to deploy VR safety training rely on technological and financial criteria to make their selections. During lab experiments students successfully learn engineering concepts. The use of virtual laboratories (VL) may help learners to overcome the challenges they encounter in traditional laboratories. VL offers teaching methods and virtual instruments formalizing the process of settings for students to solve complex problems. It also allows instructors to monitor the learning process and diagnose an issue. As a result, students can develop practical skills individually and at their own pace. Recently, the impact of XR in human life has been reviewed in a wide variety of applications, including education, training, engineering, and usability [19]. Independently, students can develop practical skills at a convenient place without being constrained by time constraints.

Several studies have found that users who received soft skill training with VR were more confident in acting on what they learned than those who received other types of training. VR offers exciting new opportunities for teaching, such as virtual laboratories, perspectives, and experiences that might be hard or unattainable to witness in the real world or the classroom. Its ability to offer a multi-sensory experience may contribute to ever more immersive environments. Moreover, VR generates a more immersive learning experience than traditional learning approaches. VL have been utilized for teaching purposes in the sciences. These technologies are available seven days a week, 24 hours a day, and can be used mainly in distance learning.

Regardless of the Covid-19 pandemic's unforeseeable circumstances, students can conduct an experiment at home and lab experiments normally using a virtual learning environment [20]. Furthermore, students can gain useful learning experiences using VL, including scenario-based training and inquiry-based learning. These techniques become a powerful tool that offers the student a good educational experience without risk, including warning tools such as tracking sensors in head-mounted display (HMD). As a result, avoiding personal injury and property damage is more important in complex circumstances [21]. In addition, learners can develop cognitive skills through experiential learning, for

instance, by being exposed to locations that would be logistically impossible to visit in person. Furthermore, simulations of activities or scenarios, learners can move beyond cognitive memorization through practice and repetition of associated procedural knowledge by bridging theories into actions.

The promising of promising VR application for students in higher education is to increase awareness of possible biases in potential future workplace situations. A certain study, theoretical framework [22] indicated that high immersion of VR may improve perceived learning results by providing students with a stronger sense of autonomy due to the complete flexibility of controlling over VLE. In contrast, according to [23] indicate that VR environments should allow the users to experience in high immersion without any artificial spatial separation between the stimuli and the users to be as actual experience.

3.2 Extended reality in training

There is an ongoing and established need for training and professionalization. VR has the capacity to be a useful tool for vocational education. VR training may simulate circumstances and create a safe learning environment for trainees in a real-world setting. VR is being used in a variety of sectors for a range of objectives, which include learning, teaching, training and safety. Presently, an increasing number of companies have created a Virtual Environment (VE) and implemented Immersive Visual Technologies (IVT), such as VR, MR, and AR in the coming years. Generally, IVT implementations spread in safety-critical sectors. safety training is one of the most recent breakthroughs such industries [24]. Highly immersive VR systems allow the user to be situated inside the computer-generated environment and to interact with the environment through physical gestures or movements. Thus, IVR would provide a sense of presence, increased agency, and high interactivity. VR users can always have the feeling of realism by engaging with all aspects of the system receiving visual and sensory responses in real time using supplementary input/output equipment that provides an intelligent training environment such as a HMD headset, sensors, controls, etc. [25].

Nowadays, industry, research, and individuals face the challenging task of collaborating and networking over long distances. An example of VR simulation-based training is the use of a simulator that is either operated or controlled by training goals in order to enable trainees improve the performance of skills on certain tasks. Briefly, the optimal training will be tailored to the users' goals, performance, skills, and capabilities. The challenges raised by replacing essential remote communication for physical presence bring up new opportunities for prolonged reality-assisted remote cooperation and learning [26]. As shown previously XR is a fundamental aspect of social distancing because it provides users with communication while decreasing feelings of isolation and loneliness.

One of the most important of these areas is industry 4.0 [18]. Specifically, VR technology can be dedicated to carrying out training processes, testing, verifying entire processes, individual devices, and industrial technologies. The same logic underlies there are huge potential advantages to mainstream VR adoption in the sector with brand-new solutions. The advancement of VR technology, as well as the accessibility of tools devoted to these technologies, allow for their use in many areas such as educational life. However, there have been attempts to develop dedicated, specialized virtual environments tailored to the requirements of different businesses. Therefore, the requirement emerges to develop a universal but comprehensive methodology to facilitate the design and creation of VR-based training [27]. The most common use of VR in manufacturing is maintenance [28]. Additionally, VR applications can also contribute to providing training for manufacturing operations [29]. This leads workers to trained in a virtual production environment with no risk involved. Therefore, there is evidence that quality of training scenarios has a significant impact on learning performance.

The Covid-19 pandemic is a worldwide epidemic that has given us a slew of new issues today that make it impossible to formulate a comprehensive view of the issue. In fact, the perspective of adverse environments and emergencies, which necessitate decision-making under time constraints and the management of complex tools in unregulated or dangerous surroundings. Virtual training is also critical for developing trained personnel without jeopardizing a current process' efficiency or harming employees [30].It accentuates the realization that is particularly critical in occupations and tasks where there is a danger of injury from a repetitive movement or position.

To deal with rapidly shifting production surroundings and new manufacturing technology, creative and efficient training programs are essential [31]. Research indicates that VR enables on-the-job, on-demand, and off-premise training in novel ways. In this context, it is worthwhile to consider that VR training apps can help to overcome these obstacles [32].

3.3 Virtual laboratories in human education

The advancement of science and technology, which is rapidly accelerating, requires the world to improve standards of education. The low learning achievement of students does not mean that they are caused by an error in the model or

method used but the need for variations in learning. The epidemic is still going strong today, with disastrous educational implications all throughout the globe [33]. As a result of this orientation, laboratory experiments have been put on hold for a long time, causing students anxiety.

In this respect, one of the most effective ways for limiting the virus's spread through human exposure is social distancing. Therefore, it is worthwhile to consider strictly complying with these social distancing measures, which required the faculty to switch to virtual teaching, including laboratories. Indeed, an innovative system is needed to integrate knowledge and learning processes that help in problem-solving, teamwork, and creation of new experiments. Recent studies confirm virtual laboratories offer the opportunity to unlock new avenues for tertiary education's long-term sustainability.

Virtual laboratories are an effective educational tool that allows students to conduct experiments Anytime, anyplace, anywhere. Briefly, it is a great opportunity to involve students with technology while also avoiding unforeseen disruptions, such as those caused by the global pandemic. Evidently, the lockdown due to Covid-19 interrupted the educational program throughout the semester. Nevertheless, theory lessons were conducted online, and academic institutions are having trouble conducting laboratory investigations as a consequence of the Covid-19 outbreak, which has caused colleges to halt lectures [34].In my view, virtual laboratories are significant in the industrial and educational sector, by virtual learning environments that provide processes for learners.

One of the main factors to shift physical laboratories to virtual alternatives before the COVID-19 pandemic is the expensive cost of operating physical laboratories. These technological advancements have greatly increased the growth of Virtual laboratories. Thus, it provide advantages such as shorter time for infrastructure and training, reduced labour costs, decreased operating expenses, equipment maintenance, space, and higher performance while guaranteeing the safety of users and infrastructure [35]. This approach has benefits as lower investment, increased approachability, and higher safety levels. The evidence for in support of this position, can be found in developing countries, especially not every academic university can afford expensive equipment, which is also expensive to maintain, purchase supplies, and most seriously replace when it breaks down.

Virtual laboratories' adaptability compensates for these limitations. The labs is a significant part of engineering and education since it helps students understand theories and concepts, collaboration, research, communication, critical thinking skills, etc. For this reason, the use of virtual labs in e-learning technology is increasing. As we have seen virtual lab is an information source that provides students with the development of practical knowledge, skills, and abilities, which allows modelling objects and processes of the surrounding world. Virtual labs should provide students with practical tasks for the development of modules of the main professional educational program containing virtual tools and means for solving them. The creation of virtual labs enables one to conduct experiments with equipment and materials corresponding to a real lab.

On the other hand, to get acquainted with a computer model for the advancement of practical skills in professional endeavors. An equally significant aspect of virtual laboratory features. Initially, it may create new intellectual models in education that are superior to actual and extra wonderful than the fantasy; it builds understanding and imparts information; it encourages and instructs pupils, and it instantly records and analyses learner data. VR technology can be used to overcome obstacles in carrying out practicums in real laboratories [36]. However, a virtual lab is a simulated object from the actual world in a virtual learning environment, and it is the most effective way to build abilities.

Virtual laboratories known as blended laboratories, can be employed as an exclusive instructional tool exclusively for undergraduate students in order to improve their lab preparation [37]. However, virtual labs activities are very important for assisting scientific learning and gaining practical skills. Another, significant factor in educational institutions could use virtual labs to expand their academic scope, achieve academic excellence, as well as provide effective training while reducing their operational expenses [38].

As a result of the growing usage of virtual labs, particularly in response to the Covid-19 epidemic, the virtual labs can implement conceptual learning, for example, lectures, seminars, and motivational learning. As a matter of fact, it provides practice technical learning skills by using scientific equipment such as interpretation and presentation. XR has the potential to blend physical, digital, and social experiential learning in hybrid learning settings, resulting in increased learning, motivation, and cooperation. Furthermore, with XR, technical or engineering-based learning and lab-based experimentation may be pulled closer together.

3.4 Extended reality theories of learning

The expanding use of multimedia tactics in the innovative teaching and learning process is aided by patterns toward updating and upgrading teaching methodologies. We need to pay more attention to training and self-development technologies, as well as improve the relationship between educational approach, virtual media, and interactive formation. In the field of education there has been lots of work done on understanding how to learn with technology. XR is an innovative and novel multimedia technology, and its educational applications are being investigated and experimented on a daily basis in higher education settings in the present decade.

In the current context, educators and scholars have given VR and Cognitive Theory of Multimedia Learning (CTML) a lot of emphases, particularly in the area of instructional design [39]. At the same time, it tries to solve the problem of learning multimedia educational approaches and employing more efficient cognitive strategies to help individuals learn more successfully. Multimedia learning is a cognitive theory of learning that predicts that more intensely IVE would increase the effectiveness of the redundancy principle learning for the trainer when employing the CTML [40].

According to this study, visual and verbal representations blend well for a healthy learning environment. Undoubtedly, each of these theoretical positions make an important contribution to our understanding of learning theory. The equivalency hypothesis is a multimedia extension of the conventional theory of learning [41], which claims that instructional practices increase learning despite the channel used or presented. Considering the growing appeal of VLE [42], it is past time to broaden the concept of instructional medium to include the physical context of learning, for instance, virtual learning at home. Learning is predicated on the learner's cognitive activity during the learning process, which is impacted by instructional technology, for instance, interacting with a scientific simulation.

Given the equivalence hypothesis based on a learning environment such as learning from home should be equal and same for the student to learn at school, because of the same teaching strategy and method, such as interacting with VE using simulation. Establishing the comparability of learning results at home or in the classroom utilizing the identical simulation provides for greater instructional time and adaptability than if overall teaching must take place in the classroom. Proving the comparability of equivalence learning outcomes at home and in the classroom, which used the same simulation empowers and increased teaching time and flexibility. The integration of virtual worlds with the Mastery Learning (ML) educational theory, towards the teaching of science.

The ML theory is advocated and assumed that more than 90% of learners can achieve learning objectives at the same mastery level if they are provided with adequate learning conditions [43]. For this reason, VR technology can be adapted to the training process and allows the student to do activities from home during the pandemic [44]. As a result, all of these three significant theories can be applied in the VR experience to increase the quality of education during the pandemic.

3.5 Extended reality challenges

The hardware tech is one of the winners in Covid-19 era. Particularly, when people were quarantined and isolated, new forms of doing were wanted, and VR is one of them [45]. The technology of VR, with its advantages and limitations, is evaluated. The implementation of this technology in education systems are improvements in cognitive skills, motivations of students, more personalization of lessons, increased attention, and access to inaccessible sites. VR can help students learn more effectively, boost memory capacity, and make much better decisions. There is no doubt that distance learning can be used to deliver practical training; however, special arrangements are required [46].

Traditional laboratory experiments have always played a prominent and unique role in scientific teaching [47]. In this context, it is worthwhile to consider about VR equipment such as VR HMD headset to be an acceleration in the growth of virtual lab experiments. In general, VR glasses and their hardware include controllers, and sensors track the motion of HMD headset, glasses, and controllers. The users can interact with objects in a virtual world, giving freedom of movement to deal with complete experience in immersive environment. The most widely utilized VR headset equipment, as well as the most common VR glasses and their characteristics, are depicted in Table 2.

The most serious objection levelled against the advancement of VR is the high cost of the hardware. Although prices have come down significantly, the cheapest glasses cost upwards of $ 399. These glasses are Oculus Quest 2 headset. These glasses can be used without an external computer, but the performance experience of headset may be lacking in some cases. A computer that allows heavier education to train smoothly will become very expensive. For example, a computer with the minimum requirements of the Oculus Rift S may cost from $ 500 upwards, and a central processing unit of almost a $1000 is required for a complete experience. In addition, the cost of developing a virtual laboratory that

simulates semiconductors is from 2000 to 5000 dollars, which is a bargain compared to a real laboratory, which costs more than three million dollars in addition to the consumption of raw materials by students during the experiments.

Table 2. List of the best Virtual reality headset and details

Name	Resolution per eye	Refresh rate	Field of view (FOV)	Tracking	Controller	Cost US$	Reference
HP Reverb G2	2160x2160	90 Hz	114 degrees	Built-in sensors	Odyssey	$599	[48]
Valve Index	1440x1600	up to 144 Hz	130 degrees	Separate sensors	Index Controllers	$999	[49]
Oculus Quest 2	1832x1920	up to 92Hz	110 degrees	Built-in sensors	Oculus Touch	$399	[50]
Oculus Rift S	2560 x 1600	80Hz	110 degrees	Built-in sensors	Oculus Touch	$399	[51]
HTC Vive Cosmos Elite	2880 x 1700	90 Hz	110 degrees	Built-in sensors	1st-gen Vive Controllers	$659	[52]

4. Conclusion

Recent research on XR is being utilized in education as provided a more complete understanding of learning process. The current findings suggest that the effect usage of digital technology tools such as VR is rapidly increasing in several fields, including education and training. However, VR utilizes digital technology and software applications, which have advanced from basic tools to more advanced and interactive tools in classrooms. As well as to increase students' engagement. For instance, this technique would enable the discovery of severe beginning locations without the group's view being deemed incorrect. Nevertheless, it may be used to train scientists pursuing their Masters and PhD degrees. Various VLE for educational and industrial purposes were created, integrated, and evaluated in recent times. Emergency, maintenance, and operator training are the top common application areas [53].

One of training application is digital twins which have been a complex and expensive process reserved for only the most technically skilled experts. Nowadays, the trainer can create photorealistic 3D models of physical environments and quickly add interactive data dashboards to the environment to show real-time IoT data to all users. Seconds later, colleagues from across the world can share the digital twin in true XR multi-user collaboration. The main challenges to implementing XR in education can also benefit educators by providing a standardized way to teach foundational skills and knowledge, as well as offering a model of a more efficient way to teach. In a virtual world, students can repeat a lesson or task as many times as they need to without hold up the rest of class.

Universities should make it possible for learners to drive XR on campus to become independent in terms of developed projects. In this context, it is worthwhile to consider self-directed learning is probably the most efficient method of learning. Respectively, Universities should give the students quick access to XR technology, particularly hardware such as VR headsets and computers with advanced graphics rendering, as well as software such as metaverse platforms.

VR is the technology for creating three-dimensional virtual environments with specifically targeted functionalities. In 2030, there will be an estimated 5 billion people living, working, and playing in the Metaverse. Researchers are seeing a trend of onboarding, training, and upskilling of employees using VR to enhance the training experience. The use of VR allows you to interact with colleagues around the world in a shared, immersive experience, and 3D objects make learning significantly easier and faster.

The education industry is now facing a significant challenge in the field of virtual reality. The complexity of developing educational content for the XR environment and the lack of qualified human resources to make this technology operational in universities, as well as the lack of funding to purchase the XR equipment and software.

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