

Challenges and practical of virtual reality applications in education

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Abstract: The use of virtual reality applications has significantly increased over the years. Within the educational realm, virtual reality tools offer various advantages: they engage learners, spark student curiosity, facilitate the sharing of information, and motivate learners to improve their academic performance. Although literature indicates that there has been substantial progress in education leading to better student learning abilities, the deployment of these tools in Higher Education Institutions (HEIs) is confined to certain subjects and fields. Furthermore, there is an observed underuse as well as improper use of virtual reality applications. Therefore, the main question addressed in this document is the practical challenges associated with implementing virtual reality in HEIs. This paper aims to explore practical issues to understand why VR is not widely adopted, particularly in these institutions. A review of existing literature was conducted, focusing on seventeen articles published between 2010 and 2026.

Keywords— virtual reality, educational experience, artificial intelligence, technologies.

1. Introduction

Virtual Reality (VR) refers to the use of computer technology to simulate real-life properties and environments artificially. Virtual reality applications are software tools that enable users to engage with 3D sound and visual experiences. According to Checa and Bustillo, these applications immerse users in a three-dimensional space, allowing interaction with virtual elements and participation in the exploration of this digital environment. The expansion of virtual reality applications has been immense across nearly all fields, having a significant influence on sectors such as Education, Training, Psychology, Marketing, Engineering and Robotics, Entertainment, Medical Treatments, Health Care, Heritage and Archaeology, Occupational Safety, and Community Skills. This paper aims to highlight the reasons behind the limited use of VR in the educational sector. Virtual reality has many uses in teaching, creating new opportunities, increasing engagement, and enhancing student comprehension, particularly in higher education. Additionally, as noted by various authors including Fernandez, Rio, Cecchini, Méndez, Mendez, and Prieto, in higher education environments, VR significantly boosts levels of student motivation, interest, understanding, and confidence in their learning processes. Recent trends regarding VR applications in education have also demonstrated that they serve as effective tools for helping learners acquire knowledge. Through these applications, students are able to enhance their understanding and learning capabilities. Cherif [28] highlighted that in the United States, around 370,000 students reportedly exit the education system each academic year due to various reasons, including a lack of motivation affecting study habits, educational support, external factors, and attitudes. These learners did not resonate well with the traditional instructional and learning approaches alone [28]. Consequently, there is a need to improve the learning environment through the effective integration of technology [29], [44]. Hence, to enhance educational quality, it is necessary to encourage the incorporation of virtual reality (VR) [30]. To develop and apply this technology successfully, adequate training must be provided for both educators and learners [13], [29], [31]. VR applications not only improve the professional growth of teacher experiences but also stimulate students' curiosity and engage their interest through effective simulations and innovative environments [5], [31], [32]. Winn [31] repositioned Constructivism as fundamental in creating educational applications. The use of VR applications exclusively expands the possibilities for students to construct and improve their understanding [1], [5]. VR settings allow students to generate models that mimic reality, and they also offer opportunities for students to gain experience in creating such environments [27], [32]. Furthermore, VR applications deliver three-dimensional (3D) representations of the structures and dynamics of any selected system. Consequently, students can grasp the principles and theories of these systems in a quicker, more efficient, and enjoyable manner by engaging with and navigating through the developed environments [27]. However, the deployment of VR applications remains limited. This document is structured into multiple sections. It begins with the study's background, followed by a literature review drawn from various open-access databases. A summary table of chosen articles is included, showcasing issues, the VR applications utilized, contributions made, and the constraints of these VR applications. In addressing the practical challenges of VR applications, suggestions for their implementation are put forward, aiming to promote the broader adoption of VR applications in higher education institutions.

2. Literature Review

In this section, various aspects related to different education fields including design, materials science, and neuropsychology were examined and evaluated concerning VR applications for teaching and learning. The findings were then summarized in Table 1. Hu-Au and Lee highlight in their work, "Virtual Reality in Education: a Tool for Learning in the Experience Age," that the use of VR in education along with its influence on teaching methods indicates a transition from the information age to the Experience Age. This shift is largely attributed to the prevailing online presence, with reports showing that 92% of teenagers are online daily to play games, broadcast their key life events, share special moments on Snapchat, or upload photos to Instagram. Consequently, many higher education institutions are adopting innovative advanced technologies, primarily integrated into collaborative frameworks and other intricate formats, to offer students experiential learning opportunities. Experiential learning presents additional advantages regarding the integration of various methods through which VR applications can be utilized to enhance students' educational progress. A study demonstrating how VR is leveraged to optimize learning is the research by Albert et al., conducted in the field of neuropsychology, titled "Investigation of Resources for Virtual Reality Applications in Neuropsychology." This study focused on identifying the resources available with VR for neuropsychological uses. It employed the VR framework to scrutinize the effects of clinical assessments and self-image to enhance patient feedback through selected cases. The findings indicated that VR is a valuable alternative for clinical evaluation and retraining. There are several characteristics linked to virtual reality that contribute to the experiential aspect of the educational process, such as interactive learning environments, visual learning, hands-on experiences, Head Mounted Display devices, and the convenience and flexibility of VR usage—all of which enhance the relevance of learning through VR applications. Furthermore, various learning activities are presented to students enrolled in courses utilizing VR applications. The engagement with these activities within the educational setting plays a crucial role directly impacting student performance. Moreover, VR applications have also provided significant opportunities for individuals with disabilities who lack the verbal or physical capabilities to experience real-life situations. In some cases, a VR application becomes essential to make the system tangible and anticipate errors that may arise within the current framework, causing disruptions, which can lead to unintended financial losses. Therefore, VR applications have become essential for teaching and providing training by introducing a realistic system model. Al Musawi et al. reported on the success of the 3D Lab in improving Omani students' achievements concerning knowledge, application, and metacognitive skills in science. To simplify the educational process, undergraduate students were tasked with creating a demonstration using VR advancement. The use of 3-D Lab significantly increased safety for students, as it helps prevent accidents from occurring. If not for this, students would otherwise be working with hazardous laboratory substances. Research findings indicated

that employing 3-D Lab notably enhanced students' interest, which in turn improved their performance. This aligns with the findings of Capatina et al., which revealed that VR tools boosted student engagement (with 72% of those surveyed affirming this), allowed for a broader audience reach, and enhanced students' enthusiasm through e-learning frameworks. Beyond those studying science, VR applications have also led to improvements in achievement levels in engineering education by creating a better learning atmosphere. Alhalabi, who evaluated different teaching methods to gauge learning outcomes and student feedback, found that the VR platform contributed positively to students' achievements. Consequently, the key aim of implementing virtual reality as an educational resource is to meet the expectations of students, particularly the youth who are modern inhabitants. VR applications are especially advantageous as they foster students' creativity and even 'disrupt established paradigms', offering them chances to apply their skills through constructivist approaches and real-world scenarios within an interactive educational setting. Additionally, VR applications significantly enhance students' identities, as they engage deeply with experiences, which is vital for memory formation, thus cultivating better learners. In their research, Dima et al. concentrated on the purposeful actions related to activity use in universities to increase student participation. The comprehensive activity demonstration was executed using graphical visual movement learning in their application program to create a foundational vision for students. The findings from the research and evaluation of the organization indicated the influence of effort expectations and student performance. Furthermore, the graphical visual movement learning application was discovered to boost creativity and communication skills among learners. Levac [2] put forth an advanced intervention framework. This focus within the medical domain emphasized several factors that may influence rehabilitation, such as perceived behavior, self-efficacy, and supportive conditions. A comprehensive mediation approach using the Intelligently Work out Restoration Framework was devised and implemented to assist physical and occupational therapists in rehabilitation units for stroke patients to ensure skill enhancement [2]. Results indicated a significant improvement when a VR application was utilized in therapists' perceived behavioral control ($p = 0.003$), self-efficacy ($p = 0.005$), and supportive conditions ($p = 0.019$) [2]. The findings also revealed that although the VR application benefited stroke patients, the sustained motivation to utilize the VR was low among therapists since the application did not enhance fine motor skills. Therefore, on the downside, particularly in the training context, certain practical challenges arise when employing VR applications [34], which in turn affects the ongoing motivation to use VR technology. One hurdle educators face when employing VR applications is their enthusiasm to interact with students [35], [36] and to access the virtual experience [31], [35], [36], [37]. Additional reasons for the limited appeal of VR applications may be attributed to the applications themselves. Each application and VR device varies in features and performance based on the technology manufacturers. Moreover, the effectiveness of these applications in enhancing the learner's competency level during educational training is also taken into account [31], [36], [37]. To investigate these issues in greater detail, a review was conducted of seventeen relevant studies, summarized in Table 1. The literature reviewed was sourced from various open access databases, including Science Direct, Ebscohost, and Scopus, particularly focusing on articles regarding virtual reality applications, their effectiveness, and influence on learning and academic achievement. Table 1 encapsulates the seventeen related studies concerning learning challenges, VR applications employed, contributions to knowledge, and identified limitations.

3.2. The Quality of Computers and the Related Applications and Technology:

Higher education institutions should also consider prioritizing investments in high-quality VR software and technology over VR hardware, as many students may already own VR devices used for gaming on their computers and mobile devices. Higher education institutions could recommend that students acquire their own VR equipment based on faculty or university suggestions when certain products become more affordable. This approach would also provide some financial savings for the institutions. The difficulties associated with utilizing VR technology [30] and external factors beyond the users' control, like poor internet connectivity causing delays and restarts [8], are additional reasons for this limitation. Such issues may discourage certain developers of VR applications. The difficulties associated with utilizing VR technology [30] and external factors beyond the users' control, like poor internet connectivity causing delays and restarts [8], are additional reasons for this limitation. Such issues may discourage certain developers of VR applications. To address this issue, higher education institutions are recommended to allocate their funds efficiently on virtual reality by advocating for the utilization of programs such as 3D Lab. This recommendation is made due to its ability to offer an online setting that mirrors real-life environments through virtual gaming and simulation applications, enabling students to engage safely with various objects, machinery, and interfaces, explore theories, and witness results prior to, or as a substitute for, participating in hazardous real-world scenarios that could pose risks to themselves or others within the simulated environments. With improvements in VR technology, the selected VR tools should be advantageous for all faculty members at higher education institutions, subsequently benefitting every sector within the industry. Numerous VR and gaming engines are presently available in the market, such as Cry Engine, Unity 3D, Unreal, among others. These engines empower VR developers to create more realistic virtual settings more swiftly and affordably than ever before, facilitating engagement between users and both natural and artificial entities. Furthermore, higher education institutions ought to select 3D Lab VR programs designed with equipment that meets required technical standards for clear, intricate representation of different phenomena. These VR innovations are consistently being refined and upgraded. Certain companies and manufacturers, for example, Qualcomm, perform better than their counterparts. Thus, prior to investing in a particular brand of VR application, higher education institutions should utilize trial versions and examine their features before committing to a choice. They should also have skilled professionals set up accounts to use and evaluate the technology, determining its suitability in relation to learning objectives and required student performance. Al Musawi et al. highlighted the importance of further investigation into different virtual laboratories in scientific education within higher education institutions. Although trial versions may have limitations, they provide insight into the functionality and user-friendliness of the virtual experience. To assess if the VR technology is accessible for novice users and if they demonstrate a consistent intention to use it, higher education institutions should encourage them to test the VR applications. A positive response would suggest that they recognize the potential of VR tools, plan to incorporate VR into their curriculum, and will partake in immersive learning experiences. Implementing such practices would result in significant investments that promote prolonged educational benefits, as the selected VR technology will be frequently updated, thus alleviating challenges related to improper usage, high expenses, difficulties in utilizing and integrating VR technology in education, inferior quality of VR technology, and related constructions. Careful research is essential to identify the most appropriate VR solutions to achieve the desired outcomes.

No	Author	Learning Issues	VR Application and contribution	Limitations of VR Application
1	Al Musawi et al. [1]	Poor achievement of the students learning	3D Lab VR application - fundamentally an internet environment that mirrors real situations through virtual recreations and reenactment program which empower learners to associated with components, machines, and interfacing securely, testing thoughts and observing the comes about some time recently or rather than conducting them in genuine life. Utilizing 3D Lab VR application, the understudies were found to have essentially progressed their metacognitive capacities in science, with their accomplishment score at 80% (15% higher than some time recently utilizing 3D Lab) [1].	Virtual labs are for the most part restricted to working with computers and gadgets with compelling specialized determinations for clear, multi-faceted visualization of marvels. Other down-to-earth issues incorporate inadequate computers and programs interior the computer and the quality of the computers and the programs [1], [2].
2	Alhalabi [3]	Poor achievement of the students	Head Mounted Show (HMD) could be a gadget that's utilized for gaming, flying, designing, and medication. There are three sorts: HMD with a following framework, Head Mounted Show Standalone (HMD-SA) with no following framework, and the Corner Cave Framework (CCS). The three distinctive VR gadgets were utilized used by three diverse bunches of understudies in this ponder. When their scores were compared, understudies utilizing HMD had higher execution (86%) than when they were not utilizing HMD (70%). HMD could be a valuable alternative for clinical evaluation and retraining. The inundation level in HMD is way better than the inundation level in HMD-SA and the CCS corner cave framework.	Three sorts of VR were utilized, but each inundation involvement was distinctive due to the number of cameras and degree of flexibility. HMD has eight cameras and 6 deg of flexibility, making it way better than the other 2 HMD sorts. In other words, distinctive HMD leads to distinctive comes about. This implies For way better comes about, superior gadgets ought to be utilized.
3	Levac [2]	Low use of VR Applications for patient therapy	A multi-faceted Knowledge Translation (KT) intervention was designed and implemented to support physical and occupational therapists in two-stroke rehabilitation units in acquiring proficiency using the Interactive Exercise Rehabilitation System IREX®. A VR therapy system places patients into virtual sports or gaming environments using immersive video gesture control technology.	In spite of the critical increment in self-reports of information and expertise, supported utilization over time, and VR request to stroke patients who felt just like the treatment utilizing IREX was locked in and fun, the application would be more advantageous in case it was suited more to the patient's needs, especially for fine engine aptitudes, which IREX does not back. When they were utilizing VR, in some cases the VR application did not work. Time pointlessly went through to urge it to work.
4	Hu-Au, E. & Lee, J.J. [4]	Students lack engagement, and they struggled to see the relevance of what they were learning to their lives.	CoSpaces and Tiltbrush, among other intuitively reenactment devices, are instruments that permit learners to make and investigate their claim VR substance. These VR applications lead to unused opportunities that bolster learners, modern	The off-base application of virtual reality in instruction would essentially rehash the instructive encounters for the learners.

Table 1 Summarized studies

1	Benedikt [17]	Low student acceptability and interest in using virtual reality applications	The capacity of VR glasses to elicit presence and a sensation of being in another environment, the use of VR glasses enables more effective targeting	Future studies are recommended to look at the post-adoption behavior of VR glasses users on a more racially and age-diverse sample. The study only provided a snapshot of how VR glasses were received, but factors that influence user acceptability may
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techniques for media like games and videos. change over time and in different contexts. In particular, it is reasonable to anticipate that the novelty appeal of VR glasses will fade with time, and future study may identify other important factors that influence the adoption of VR glasses.

2	Valenti et al. [16]	Possibility of employing VR apps to improve learning, address current issues, and boost learner engagement.	Physical presence is far more accurately simulated with Cardboard VR than it is through static or non-immersive films and texts.	Some VR headsets' delayed delivery caused delays in its distribution to students, who as a result had less opportunities to evaluate the material than they could have. Many students decided not to participate because they were having trouble using the VR technology since difficult for distance learners to access the equipment.
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The sample cannot be generalized because generate more thorough pedagogical insights the majority of its participants are Americans and are mostly between the ages of 18 and 24. By using various educational platforms, it should be possible to investigate how learners' virtual experiences affect how well they learn. Future research should concentrate on additional psychological factors related to implementable design factors of virtual environments in order to

3 Huang et al. [15] The distance between a learner's theoretical understanding and practical experience must be closed.

The study applied self-determination theory and hedonic theory using a simulation of a virtual 3D mall. Based on the sensation of autonomy and sense of community in virtual worlds, the 3D VR application improved intrinsic motivation and engagement in the virtual domain, according to the results.

looked at three psychological factors and neglected to take other possible motivational factors into account.

The VRTS gave educational stakeholders information that they could use to enhance the training of line

VRTS in order to increase the validity of the findings and make the technology more familiar to

4 Baceviciute et al. [14] Engaging students in scientific classes is difficult. users of an immersive 78 virtual reality (VR) program re given the same teaching material in three distinct formats: voice, text in an overlay interface, and text semantically incorporated into a Learning outcome measurements, self-reports, and an electroencephalogram (EEG) were utilized to compare which of the three various forms delivered was most successful. Reading from a virtual book was the least cognitively taxing

5 Santamaria et al. [13] reducing danger when instructing in live-line maintenance, a dangerous task. The ALEn (Energized Lines Maintenance Training) VR workers, their involvement in learning-supporting activities, and their capacity to identify untrained pupils. This study's focus was on a particular geographical area and body of professors and students. This study also makes recommendations for future research, including the adoption of a formal knowledge model, a human teacher, and a balanced data sample to help detect untrained

6 Halaweh [12] application of emerging technology or ET is lacking. The HMD VR application was utilized in this case study to improve learning outcomes by creating a paradigm for technology adoption (META). confirmation via the VR example. The HMD VR application was utilized in this case study to improve learning outcomes by creating a paradigm for technology adoption (META). firmation via the VR example. VR. Self-efficacy and quick attentiveness are two advantages of utilizing VR. These findings offer crucial suggestions for creating VR learning environments. virtual book. The participants of the three situations compared to wore HMDs to fully experience reading from an overlay interface. In ; of learning objectives like recall, self-efficacy, and unimportant attention, it was likewise more effective than listening. According to EEG studies, theta and alpha waves were much less active during auditory situations. Additionally, it was discovered that HMD limited body motions.

7 Training System (VRTS) was unveiled, and the effectiveness of the trainees' performance during a number of maintenance maneuvers (MMs) in a VRTS was evaluated. information; therefore, its findings might only apply in that context. Future study should thus make use of various Xiaozhe Yang et al. [11] Individual creative A VR program is HTC Vive. Users performance One restriction was that each pupil was only allowed five minutes. The technology and build quality of the gadgets were also the subject of technical problems. creativity. created by HTC and Valve may move in 3D space (an immersive virtual reality environment) and employ motions that improve concentration, flow, and meditation.

The HMD VR application was result of the activity spaces' lack of

8 na Dajani [10] There isn't much animation used in educational settings, especially at Jordanian institutions. Lack of creativity and communication skills among students The results of 320 completed surveys that were randomly distributed to 370 marketing students in freshman through senior year classroom settings who had utilized animation at Although learners have more creativity and communication skills, sample size is tiny and the results cannot be generalized.

9 Yang et al. [9] Low achievement of students least once in their marketing classes revealed that they valued the usage of animation. The study offers helpful strategies for teaching and learning for professionals in the marketing area. introduced as a new platform for the students to engage in exploration, education, and creative expression. A significant number of pupils and a lack of VR equipment made the allotted time to utilize the HMD VR application inadequate. Contrary to conventional learning, immersive VR added a sensation of stress. This is a dimensions. Only when pupils are aware of them can their creativity and objectives associated to creativity, such as

meditation, flow, and attentiveness, be attained.

(perhaps due to the novelty of the manages were created to be seen on all devices,

10	Chien Wen an et al. [8]	ievement of the students	search hypotheses about the influences of four modes of learning styles on students' behavioral intents to use VR HMDs were examined using experiential learning theory (ELT). Engineering students were given access to virtual reality headsets (VRH) and head ed displays (HMDs) to learn about VR.	reality immersion was not an option for participants. A comprehensive learning experience in terms of transformation cannot be provided by reflective observation and active experimentation alone. This restriction prevented the implementation of a true VR HMD learning experience for the pupils.
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developers by creating the VLE. However, if they were only using the VLE for learning, it would not be t was for non-technical students.

12	Erdem, Hakan, Turhan, & Ilhan [6]	t was shown that gifted students had difficulty ehending chemical connections.	Thirty of 52 gifted students (vey group) were given a force feedback haptic augmented simulation (using Phantom Omni, Open Haptics, Open Haptics libraries, Visual C++, OpenGL VR, and 3D spectacle (Head-Mounted Display - Wrap 1200)) on chemical bonds, and they found to be more interesting than the conventional teaching methods. irtual reality (VR) programs known as Force Feedback Haptic Applications in Virtual Reality Environments (FFHAVRE) let users engage with the virtual environment and simulate touch by applying force, vibrations, or motion.	The drawback would be that because the control group was not exposed to they were ill-equipped to express their opinions on the topic as a teaching strategy. As a result, further research must be conducted utilizing various qualified sampling groups to draw comparisons.
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11	Nishaben Desai et al.	Using passive learning effectively in standard and constructivist safety training methods	contents). Perhaps the VLE would be more attractive to technical students as users/rather than as creators if it were created by professional designers and professional developers. The VLE was not as engaging to students who were not technical as it was to those who were, even though they would learn a lot as	including PCs, smartphones, and tablets, as well as with VR headsets like the OCULUS, RIFT, HTC Vive, Oculus Gear, and Google cardboard. gadgets for VR headsets. The ability of professors and students to incorporate VR technologies into their work, as well as the affordability of VR technologies to be integrated to a greater extent in academia, have all been questioned despite the positive interest (72%) in the VR application and its benefits and abilities to build scholarly brand awareness.
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The Virtual Reality Interactive Learning Environment (VRILE) was created by engineering students to create an interactive environment for chemical laboratory safety. Instead of being a latent beneficiary or a passive recipient, students were actively involved in learning using Kolb's Experiential Learning Theory (ELT).

nce the VLE and games were created by the students, they were undoubtedly simplistic. Because of this, non-technical students considered the materials to be more fascinating than technical students

Capatina, Possibility of adopting VR Schin & Rusu apps to address current [5]demands, improve student engagement, and make learning more desirable The virtual reality tours that Brand Verisign Media

14	Hu-Au, E. & Lee, J.J. [4]	The lack of involvement for them to connect they were learning to and develop experiences would be the incorrect their own VR material. These Applications for VR create new possibilities for education, fresh viewpoints, empathy, creativity, and the ng of complicated models, systems.	CoSpaces and Tiltbrush are two tools for interactive simulation They enable students to explore experiences would be the incorrect their own VR material. These use of virtual reality in the classroom.	among students made it examples. difficult Repetition of the learner's educational their daily lives.
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Despite the review's narrow emphasis on academic achievement, various trends may be seen in Table 1. In several fields of education, including metacognitive skills in science [1], clinical evaluation and retraining [3], engineers and instructional foundations [8], and engineering area [7], virtual reality applications may be utilized to improve learning motivation and academic achievement. For instance, the rise varied from 70% to 86% [3], clearly demonstrating that the majority of students had a favorable opinion of VR. Additionally, studies have shown that students' views about utilizing the 3DL Virtual Reality program in their learning were favorable, which improved their logical and visual thinking [1].

The use of animation in VR has been shown to increase students' inventiveness [3, [5,] [8,] and the VR system for therapists successfully integrated e-learning, experiential learning, and a reminder feature in the application that has significantly increased self-reported confidence, knowledge, and skills in VR use [2] are other findings from the literature.

Thirdly, virtual reality applications employed in the realms of education and learning as well as to improve academic performance were utilized in situations or regions where learning in the real world poses risks and places them in all of these risky domains without injuring them. [7], [17], [18]. Learners could be trained to perform in a variety of ways thanks to VR simulations, which also enabled them to learn more about specialized subjects like

chemistry, medicine, and other fields where safety is a key issue.

The literature evaluated in Table 1 also indicated that VR applications do have certain drawbacks, despite the utility of VR and students' acceptance of VR, which showed a favorable effect of VR in terms of appropriateness, learners' engagement, and their performance [6], [7], [10], [15], [17].

Three major constraints may be used to summarize VR concerns; these restrictions will be covered in more detail in the next section, along with advice for how to overcome them. Each suggestion is based on the restrictions inferred from the examined literature.

The literature review made it abundantly clear that the use of VR in higher education institutions and other learning environments is crucial, and that we must get past these three major obstacles: (1) the belief that using VR is expensive and not always effective; (2) the caliber of computers and the related applications and technology; and (3) the lack of confidence among instructors in using VR, or more specifically, their reluctance to leave their comfort zones.

3. Limitations of and Recommendations for VR Applications Use in HEIs:

Based on the three primary difficulties discussed earlier and recommendations made in this part, HEIs can start employing VR apps or boost their usage of VR to improve students' performance.

3.1. VR is Costly and Not Necessarily Effective

According to the analysis in Table 1, one important finding is that VR applications are thought to be quite expensive [1], [2], [5], [9], [12], and [16] and might not address a particular problem [2]. Leva [2] noted that the VR the therapists employed did not assist fine motor abilities for individuals undergoing rehabilitation. Similar to how Baceviciute et al. [14] noted that the devices employed constrained physiological movements, it is imperative that VR applications meet the desired learning results if VR is to be deployed in HEIs. Therefore, the administration of the individual institutions may believe that their choice should be based on which courses would profit from the investment of VR applications the most. The administration should choose VR programs for classes where students would be particularly at risk. In view of the limitations in terms of cost, this article makes recommendations on how to exploit and optimize the usage of VR applications in HEIs. The adoption of VR apps and the utilization of VR technology might significantly aid in student learning. Originally of all, it is advised that HEIs invest in VR tools that are now more reasonably priced than they were when they were first released into the market, such as Google Cardboard. The Oculus Rift originally cost \$599, and Robertson [38] claims that its setup required a gaming PC that would cost at least \$1,000. Table 2 below shows how much less expensive VR viewers will be in 2026 than they will be in 2019.

Table 3 The cost of the Oculus viewers in the market 2026:

Model	Oculus CV 1	Oculus Rift	Oculus Go(stand Alone)	Oculus Quest
Specifications	1080×1200, 90 refresh rate, and a 110° field of view.	2560×1440 Refresh: 80Hz.	2560 x 1440 Refresh Rate: 72Hz	3220×2880 Refresh Rate: 72Hz
Price (USD)	599	499	450	299

This table illustrates the dramatic decline in pricing for the Oculus cv1, Oculus Rift, Oculus Go, and most recently, the Oculus Quest. The prices listed above represent the starting pricing for the various Oculus versions as well as the current prices as of March 2026. This demonstrates that VR technology is actually becoming more and more accessible. The displayed resolution is also raised for better graphics presentation in addition to the pricing. To conclude, and as shown by Table 2, HEIs should think about investing in AR, MR, and VR technologies and apps since they will have a greater impact on how people live, work, and play in the future. HEIs should proactively think about researching the changing market demands in important industries (including retail, logistics, the built environment, and media entertainment) and evaluating the resources available to reevaluate the best technologies to invest in. For instance, Google is always working to enhance its VR products, including a cardboard smartphone. The cost of the gadget was far higher when it was originally released than it is now. Now, buyers can purchase much better, newer, and upgraded technology for a fraction of the cost—as little as USD 10 (during a sale). This has really widened the public's access to VR by making it more inexpensive for individuals to partake in the experience. Since the cost of VR has dropped significantly, the advantages of using VR applications in education are immeasurable when it comes to improving student engagement and academic achievement [39]. Second, by investing in VR technologies that are often utilized by many applications for different courses, HEIs may be able to save costs. Google Cardboard, for instance, may be applied to engineering and medical research (Oculus Rift). In several academic subjects, VR headsets like the HTC Vive, Google Cardboard, and Samsung Gear VR are employed. Thirdly, by sharing the network and utilizing a wireless connection, HEIs might invest in software that allows several students to utilize it at once. VR devices have evolved from having a very large and complex setup that was connected and limited user engagement to standalone wireless devices. Users can move around with more flexibility because PCs are no longer necessary [8]. Additionally, since a PC is no longer necessary, the price of a VR product has significantly decreased. Albert et al [18].s use of VR for group work employing neuropsychological applications is one example of this. Other examples include the engineering applications by Desai et al. [7], the scientific applications by Baceviciute et al. [14], and the chemical applications by Erdem et al. [6]. Fourth, the HEIs may create a VR center with a variety of VR applications to accommodate a large number of students. The Virtual Reality Applications Center (VRAC) at Iowa State University has carried out this [40]. This will get over Yang's [9] criticism that pupils didn't have enough time to fully immerse themselves in VR. The advantage of establishing a center is that the VR tools and software that the HEIs have purchased will be simple to administer and monitor. The HEIs should also think about forgoing investments in VR equipment in favor of spending more on high-quality VR software and technology, as it's possible that many students already have their own VR devices that they use to play games on their computers and mobile devices. The HEIs could advise students to purchase their own VR gear based on university or instructor recommendations when some products become more inexpensive. HEIs will save some money as a result of this.

3.2. The Quality of Computers and the Related Applications and Technology: The HEIs should also think about forgoing investments in VR equipment in favor of spending more on high-quality VR software and technology, as it's possible that many students already have their own VR devices that they use to play games on their computers and mobile devices. The HEIs could advise students to purchase their own VR

gear based on university or instructor recommendations when some products become more inexpensive. HEIs will save some money as a result of this. The complexity of using VR technology [30] and other variables outside the users' control, such as low internet quality that results in lagging and restarting [8], are further reasons for this restriction. For some VR application developers, these factors could be discouraging. The complexity of using VR technology [30] and other variables outside the users' control, such as low internet quality that results in lagging and restarting [8], are further reasons for this restriction. For some VR application developers, these factors could be discouraging. To get around this, HEIs are urged to spend their money wisely on VR by suggesting the usage of programs like 3D Lab. This is advised because it creates an online environment that closely resembles actual environments through virtual games and simulation software, allowing learners to interact safely with objects, machines, and interfaces, testing theories, and observing the outcomes before or in place of engaging in risky activities in actual real-life situations that could endanger the students or the people in the simulated contexts and environments [43]. With the advancements in VR technology, the chosen VR applications should benefit every faculty member in the HEIs and, as a result, every industry in the market [41]. There are now several VR/games engines on the market, including Cry Engine, Unity 3D, Unreal, and many others. With the help of these engines, VR developers can produce more lifelike virtual environments more rapidly and cheaply than previously, which makes it easier for users and developers to interact with both real and manufactured species [32]. Additionally, HEIs should pick 3D Lab VR programs that were created with equipment that met the necessary technical requirements for crystal-clear, multifaceted representation of the phenomena. These VR technologies are continuously updated and enhanced. Some businesses and producers, like Qualcomm, are superior than others. Therefore, before making an investment in a specific brand of VR application, HEIs should make use of any trial versions and test their features before choosing one to commit to. They should also have some competent practitioners create accounts so they can use and test the technology and determine whether they suit the learning outcomes and achieve required learner performance. Al Musawi et al. [1] The necessity for greater study on various virtual labs in scientific teaching at higher education institutions was stressed. Trial versions do have certain restrictions, but they also give you an idea of how the virtual world works and how user-friendly and sophisticated it is. In order to determine whether the VR technology is simple for beginner users to use and whether they have a consistent behavioral intention to utilize it, HEIs should ask them to test the VR apps. If they do, it would indicate that they see the potential of VR applications, would include VR into their courses, and would engage in immersive experiences. Doing this would lead to meaningful investment that would sustain learning for a longer period as the selected VR technology would be constantly being upgraded and thus preventing issues related to the wrong way of using VR technology, high cost of VR technology, the difficulties of using VR technology and adopting it in education, poor quality of VR technology and the VR constructions. Proper research is required before selecting the most suitable VR to obtain the desired results.

3.3. The Lack of Confidence of Instructors to Use VR: Because they were unfamiliar with the technology, teachers were reported in the literature to lack the confidence to employ VR [4], [13]. Due to their discomfort with the technology, some students were also reluctant to give it a go [13]. No one will employ VR in HEIs unless it is required or mandated from above. This article suggests that, in order to get over this restriction, HEIs could give teachers VR training, as suggested by Al Musawi et al. [1], Santamara et al. [13], and Priatna et al. [30]. Sometimes lack of knowledge is the cause of low VR intention. The professors often aren't used to employing technology, especially the more senior ones, who instead favor the more traditional teaching techniques [10]. The advantages of having such training would be that after learning the tools, the professors or instructors would show the students how to utilize VR and ask them to apply. Additionally, teachers would be able to choose the course materials and content that would work best with VR applications and how to help students understand the objectives for that subject. Second, the method used by Desai et al. [7] might be imitated when using VR apps to tailor them to the needs of learners. It was more intriguing and engaging for the students in [7] when the professors required them to create their own VR. To construct the VR environment, they had to work in groups and do research; from one semester to the next, the students would improve the VR that had already been created. Students can learn through cooperation and lifetime learning as a result of this activity. This serves as an example of how constructivism is essential to the creation of educational apps. The use of VR apps expands students' opportunities only to develop and improve their knowledge [1], [5]. Students may design a model that replicates reality in VR surroundings, and they also get experience in building such environments. This, however, cannot be done if teachers are unaware of the VR tools at their disposal and how they might be used to enhance learning. As Al Musawi et al. [1] To get the kids' attention, more instruction, practice, and curriculum development are recommended [1]. Due to this, educators must have the necessary training. Last but not least, replicating Desai et al [7]'s method of having students design their own VR environment would keep the expenses cheaper than buying pre-existing software and equipment. Additionally, the timetables of the students could be set up so that they may use the laboratories in succession at various times and utilize the shared devices on the same network.

- 4. Significance of the Study:** This study is important because it compared and analyzed prior research on the methodologies used in various VR technologies using criteria including 1) the costeffectiveness of VR application tools, 2) the sustainability of VR use, and 3) the technological sophistication of teachers. The fact that the conclusions and analysis were based on 17 studies, however, is a restriction. If more papers were evaluated, perhaps more problems would show themselves. This study discovered that the majority of the problems may be divided into three major groups. This research is particularly essential because it offers suggestions for how HEIs might get beyond these obstacles and employ VR apps to engage students and improve student performance, which will help students meet their learning objectives.
- 5. Conclusion:** The literature review has shown that virtual reality applications unquestionably have a positive impact on students during the learning process, enabling them to enhance learning outcomes, safely engage in experiences that are ordinarily risky, cultivate intrinsic motivation, and heighten interest in learning. In other words, the benefits of VR applications are evident. Despite students' greater interest and involvement in virtual reality than in the conventional paradigm of education, literature has also demonstrated that virtual reality has not yet realized its full potential. The three primary causes of VR's underutilization have been outlined in this research. Virtual reality (VR) is typically thought to be expensive and ineffective. The second justification has to do with the caliber of computers and the associated software and technology. Finally, those who are less tech-savvy see it as a challenge. But these might be solved with proper preparation and smart choices. To fully realize the potential of VR applications in accomplishing learning goals in a way that students look forward to and are enthused about, educators' training will be of utmost importance. Thus, virtual reality apps are worthwhile investments since their use affects students' engagement and academic achievement, especially in instances where real-life scenarios are too risky, such as in several engineering and medical areas. Future artificial reality-enhanced learning systems will be fascinating to watch as we integrate virtual reality technologies to produce more lifelike pictures and graphics that more accurately replicate reality. Virtual reality applications are currently being employed not just in the educational sector but also in everyday life and the workplace. However, pupils would miss out on learning that may be more valuable than the standard techniques if instructors were unwilling to go into the "uncertain." Virtual reality applications represent the future of education, but if their promise is not fully realized, there is little hope for VR applications in general and education in particular. Future study is planned to illustrate the growth in VR applications, analyze how they have been deployed, and determine whether educators are more receptive to employing them in the classroom as a result of the practical strategies for increasing VR applications in HEIs that have been suggested.

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