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RESEARCH ARTICLE

Role of Virtual Reality in Contemporary Education: Examining How Virtual Reality is Impacting Academic Self-Efficacy, Educational Cost, Cross-Cultural Education and Interactive Learning Environments

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ABSTRACT

Virtual reality technology (VR) has exhibited exceptional potential in educational applications, particularly in bolstering students' academic self-efficacy. This paper focuses on a comprehensive synthesis of recent scholarly work (30 existing papers) to scrutinize VR's impact on diverse learning contexts, its benefits, and lingering obstacles. The examination reveals that the immersive and interactive nature of VR environments significantly enhances learner engagement and augments academic self-assurance. Nevertheless, a paucity of interdisciplinary and cross-cultural investigations persists in the examination of VR's efficacy. Furthermore, research endeavours addressing VR implementation in resource-constrained settings and its enduring effects are scarce. To address these gaps, this paper introduces an innovative theoretical paradigm designed to optimize VR integration in educational practices, advocating for tiered strategies tailored to specific pedagogical requirements, broadening trans-cultural explorations, and formulating plans concerning cost-effectiveness and long-term implications.

1. INTRODUCTION

VR equipment changes how teachers teach by building digital classrooms that trigger student participation and understanding. Learners connect better with VR systems because the virtual world lets them see key ideas directly. Students understand science principles more effectively when they use VR technology to explore virtual scientific tools according to research findings. VR lets students learn more effectively since they experience hands-on interactions in a virtual environment without distractions. Educational applications of VR have increased because of its development from basic desktop PCs to wearable headsets [7]. Studies about VR mainly target university levels of higher education plus engineering science and healthcare fields but extend only partly to primary and secondary school education [77]. Using VR helps students learn better by applying what they see and do which validates constructivist and experiential teaching principles [72]. The visually rich environment in VR enables students to grow their task confidence through active learning experiences. Students improve their academic success when they interact with others and receive real-time responses while enjoying emotional engagement in VR environments. VR shows proven benefits but these benefits differ depending on where and how it's used. Many students learn better and participate more in VR-based education yet developed nations still show slower VR adoption rates while teachers face content-overload problems [27]. VR works better in specific regions and when users match local traditions [25]. A basic plan for bringing VR into classrooms will help reduce these funding and implementation gaps.

VR enables students to learn new abilities through controlled mental development tools. Students learn better speaking skills when they use VR to interact with digital avatars that deliver immediate response feedback. Students develop emotional strength and learn to work together better through virtual reality [79]. Current research should study VR's educational effects by comparing student groups and tracking performance through time [11]. Only rich communities can afford both the latest technology and VR software packages. VR learning outcomes vary based on how well students work with different learning methods and their comfort with technology so research needs to explore this across different educational environments [8]. Current VR devices primarily rest on two main categories: standalone headsets including Oculus Quest or PC-linked systems like HTC Vive [32]. The combination of low-priced hardware and easy operation in standalone VR devices makes them perfect for teaching across modestly equipped educational facilities [74]. Schools can use these devices right away because they require no additional computers or tracking sensors and require minimal technical skills. People get better graphical quality and user engagement from PC-tethered systems yet installation costs and setup complexity remain high [21]. VR systems designed for engineering and medical applications prove effective but do not fit within the budget range of poorly funded schools [58]. Standalone VR headsets help educational institutions meet performance needs while staying within their budget [80]. PC-tethered systems offer exceptional results when running complex applications [22]. The difference in cost shows that every student deserves access to VR learning technology no matter what resources they have [20]. The review shows how VR can boost confidence and education results while focusing on its main problems [84]. Successful implementation needs solutions for expenses plus respect for cultural backgrounds and future student impacts. Research teams should study ways to make VR cost-effective while exploring how this technology works among different student groups and for lasting educational benefits [28]. The strategic use of VR in education creates new ways to teach that improve student engagement and confidence regardless of their learning environment.

2. LITERATURE REVIEW

Evolution and adoption of VR in education

The practice of Virtual Reality entered education fields during the 1960s as simple virtual reality started systems. Users can now use VR equipment at affordable prices to conduct educational and business activities because essential updates made VR more accessible [78]. VR produces active realistic spaces that help students learn better which makes it important for education [69]. Current VR usage remains limited due to its price tags and activity hardships that affect both users and implementers [56]. During the last ten years, VR technology experienced strong growth in adult and higher education especially when used for safe medical and engineering practices [75]. Students in VR environments can practice complex skills safely to avoid the risks of practical training. In their training medical students use VR to practice surgery and engineering students use VR to operate virtual tools [90]. Although schools seldom use VR today the technology promises to engage young students and boost their motivation because of its interactive learning options.

Benefits and challenges of VR for young learners

Data shows VR benefits especially help students with learning disabilities when learning at a young age. Through this space, students build hands-on skills that they can use outside of the classroom. Many scientists hesitate to study VR's safety impact on children because it poses possible risks to their bodies and minds [31]. The VR industry must solve digital sickness problems and screen time side effects to make VR safe for child users. VR technology works better for education in the developed world because developing countries need better educational infrastructure to use it effectively [23]. VR education in developing regions meets many barriers from insufficient electronic technology and limited access to trained professionals [10]. Research needs to extend beyond short-term testing to show how well students keep their VR-based knowledge and perform in school [102].

Ethical considerations in VR use

Privacy concerns

Virtual reality platforms track important data about how people think, what they feel and their physical health which raises major privacy problems. Virtual reality headsets track both eye movements and brain signals during use [49]. The routine use of VR technology with children creates extra data protection risks during their learning experiences [57]. Schools need to set strong data security standards while hiding vital personal information and defining how user data should be collected and processed [24]. To protect personal information students and parents must be made fully aware of collection practices so they can waive their consent from collecting non-essential data.

Psychological impact of prolonged VR exposure

Using VR for long periods creates a discomfort that combines with cybersickness and shows up as eye problems, nausea, and headache symptoms. Internet users under 18 years tend to develop stronger side effects including vision problems and problems with their balance plus difficulty seeing the real world [35]. VR creates strong emotional reactions in students but these reactions grow too intense when they experience intense emotional simulations [103]. Educators should stick to stated time limits when students use VR and screen content according to age recommendations [6]. VR technology should not take up more than two hours of a child's daily screen time according to the American Academy of Pediatrics [29].

Over-reliance on technology

More use of virtual reality and digital tools in education worries teachers about losing proven classroom practices. Unlike virtual reality, VR does not replace basic educational practices because students require face-to-face interactions and problem-solving activities [2]. Extensive use of VR makes students more consumer-like learners instead of independent learners [60]. Teachers need to carefully add VR lessons to their plans by using VR to support important learning outcomes [44]. The training system for teachers includes learning help to combine VR tech with normal methods plus improving student interactions that develop skills and thinking abilities [33].

Mitigating challenges through responsible use

Designing ethical VR tools means developing proven rules for building and using virtual reality devices. Schools need to make user privacy their top priority along with selecting content that matches each student's age group and giving teachers the tools they need to control VR use [31]. School managers need to create rules about what data students' data get tracked and how long students can work in VR to ensure student protection [11]. When educational VR works best with standard classroom methods educators need to control how students use technology. VR treats students well when educators use it correctly to teach and support them.

3. METHOD

For the purpose of studying the contributions and role of VR in contemporary education, this study has selected 30 existing scholarly papers from various journals with inclusive and exclusive criteria. The inclusive criteria include peer-reviewed papers, published in English languages, published between 2017-2024 and relevant to VR uses in education. The collected data (information from the 30 papers) are analysed using thematic analysis approaches. Ethical implications of avoiding mis-presentations of data, giving credit to the authors and avoiding data manipulation have been strictly followed.

4. MAIN FINDINGS

Virtual reality technology has spread across Primary, Secondary and Tertiary educational systems. This study's analysis of 30 top-tier research papers during 2014-2023 shows researchers mostly study how VR benefits learning and connects different subjects [64]. Most available studies concentrate on VR advantages in education while giving minor attention to actual expenses and related cultural aspects plus the lasting effects of VR in learning settings [34].

VR in education: themes and trends

Research shows virtual reality can develop interesting education settings that benefit students across science, engineering, medical knowledge, and language classes [82]. Recent research shows VR improves educational engagement and student motivation just as previous studies showed VR worked in different learning environments [69]. Many parts remain unknown about how VR affects education in the long term and why this technology costs more in limited resource areas.

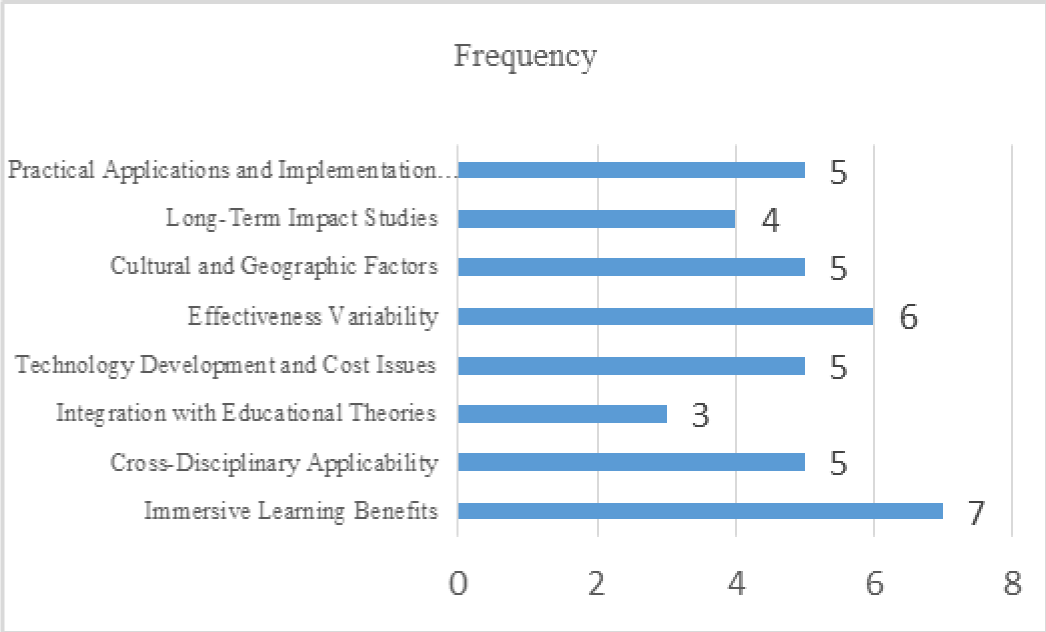

Figure 1: The summary of literature based on themes (source: self-created based on the selected papers)

Figure 2 shows that researchers mostly explore virtual reality's immersive potential for different subjects yet they face barriers like cost problems and research follow-ups. To make VR more widely available and effective in education the field needs to solve these existing problems.

Self-efficacy: definition and relevance

How well someone thinks they can handle class assignments strongly affects their educational results. When people believe in their abilities they become more curious and resilient while achieving more [71]. Albert Bandura shows self-efficacy controls study efforts and perseverance until students reach their learning goals. Students who believe in their abilities study the learning content more intensely and keep working on tough assignments [70]. Beyond schoolwork, self-efficacy affects how people take care of themselves both physically and emotionally and decides what they do for work [3]. People with high self-efficacy stick with healthy routines and use medical guidance better than others while recovering quickly from difficulties [91]. When strong self-efficacy exists in employees they easily adapt to new technology at work, take on challenging tasks and often lead their teams [76].

Mechanisms to enhance self-efficacy

Through VR users learn and grow by engaging with digital environments that respond to their actions as they practice. Through virtual science labs, students perform experiments and analyze data which helps them develop greater self-assurance [90]. VR's simulation platforms and interactive tools build students' beliefs in their own skills while enhancing team morale and dedication which enhances their education results [62].

Bandura identified four key sources of self-efficacy:

Mastery experiences: Strong results in growing levels of difficulty strengthen inner confidence. Educational programs should create tasks that let students achieve more with time [45].

Vicarious experiences: Seeing friends or leaders achieve goals builds people's trust in what people can do when they seem familiar to us.

Verbal persuasion: Believable guidance from teachers and supervisors at work helps students stay strong during hard times [73].

Emotional and physical states: Good feelings make people believe in their own powers but stress and fear break down their trust in themselves [90]. By creating calm spaces and teaching people relaxation methods health providers assist people to cope with their condition [36].

Professional growth programs use these learning methods to help team members grow their self-assurance. Teachers help students develop self-assurance by letting them work together in teams and giving sound guidance plus feedback alongside personal review [92].

Addressing gaps and expanding research

Although VR shows promising outcomes for teaching methods and student self-assurance, the research needs to progress to explore its sustained impact across all backgrounds and its price challenges [43]. Creating platforms that accommodate cost, reachability, and performance needs represents the path to widespread VR use in many environments [4]. Individualized strategies built to align with both person-specific and cultural backgrounds let VR help students at every level of education. Virtual reality programs that build students' confidence create better results in their studies and help them succeed in both life and work. Providing strong platforms and careful setup will help VR become its best tool in education.

5. CURRENT CASES OF VIRTUAL REALITY APPLICATIONS

Case 1: Application in high school students

Virtual reality helps high school students develop better scientific self-confidence according to research findings. A study involving 66 students divided them into two groups: The researchers tested two separate groups who each filled out a self-efficacy measurement ahead of their VR science class and after completing the study [37]. Students showed better self-assurance after learning with virtual reality methods especially when they needed to grasp difficult scientific basics and perform experiments [46]. Due to the minimal number of participants in this research the obtained results cannot be expanded across different scenarios. Students can now enhance their educational experience through VR because they test scientific theories in virtual labs and visualize demanding subjects across all science topics [46]. The virtual reality system helps students better understand molecular structures and easily grasp difficult material. Students gain a better historical understanding when they can visit virtual versions of past events and visit ancient societies like real tourists [63]. VR technology creates rich history studies by giving students exploration opportunities in historic environments. The virtual reality environment helps students connect better with fictional narratives by interacting directly with characters and backgrounds in their books [86]. Through VR physical education students get valuable sports training experience regardless of space or gear constraints. This inclusivity ensures greater participation [42]. Higher schools accept VR technology to train students in modern skills and tailor learning experiences as VR technologies improve.

Case 2: Application in teacher training

Trainers successfully use virtual reality systems because these setups help their students develop teaching skills in realistic virtual environments. Research with teacher trainees demonstrates that VR leads to better teaching skills while building creativity and problem-solving strength [49]. Through VR practice trainees get to repeat classroom simulations which help them become more confident teachers. Despite the VR benefits of helping students learn better, many educators need focused training courses to succeed [104]. Research shows teachers lack technical readiness to use VR in their classrooms. Instructors need proper technology training to bring out the system's true benefits and gain better student participation [49]. To fix this issue schools need ongoing professional development training sessions [100]. Educators receive professional workshops and training plus VR certifications to master how VR will improve their teaching experience. These projects develop educators who know how to use VR in their classes and whose efforts boost student success [30]. VR offers great potential to improve education practices when educators have all the tools they need.

Case 3: Application in medical education

Medical schools use VR to give students a protected place to practice surgery training and gain hands-on clinical skills. Students learn real operating room experiences through VR that lets them practice sewing stitches and delivering injections [41]. Hands-on training enhances student skills and lowers mistakes according to research that showed students learned more efficiently and felt more confident. Students can use virtual reality to practice cardiac and neurosurgery procedures as much as needed because VR avoids endangering actual patients [41]. VR feedback systems enable students to see their mistakes immediately while learning in VR [47]. With VR technology students learn effective patient interaction techniques while also developing emotional connection skills and cross-cultural understanding [38]. Patients receive better healthcare when providers train together in virtual reality environments [87]. Although VR systems cost a lot, the benefits they bring to medical training make them worth investing in for educational institutions that want to teach better healthcare staff.

Case 4: Higher education: Stanford University's virtual reality lab

Stanford University Medical School uses HTC Vive and Oculus Rift VR devices to implement training for difficult surgical instructions. Pupils gain operating expertise by performing coronary artery bypass and heart valve repair tasks inside a 3D replica of an operating room that provides them with natural touch feedback during their lessons. Research demonstrates that VR learning produces surgical students who become faster and more precise operators than their classroom-trained counterparts [85]. Students develop better skills through practice because they do not need human subjects or physical equipment during sessions. VR education takes away mental stress so students can learn tasks thoroughly with no risk of failure in real situations. Besides cardiology, Stanford achieves VR benefits in the fields of neurology and orthopaedic surgery [85]. Through its immersive VR training techniques, the university shows that higher education can teach students the best ways to handle medical problems with VR technologies.

Case 5: K-12 Education: McKinley technology high school

McKinley Technology High School in Washington D.C. brings virtual reality into its STEM program to help students learn in an active environment. The school works with Verizon Innovative Learning to let students enjoy Google Expeditions as virtual field trips. School groups like history students walk among ancient ruins but biology students swim underwater to examine natural marine habitats [58]. Students show stronger interest in their studies and they achieve better science and history grades thanks to the program. When students experience VR they take charge of their own learning which builds their natural curiosity about the world [98]. VR helps teachers create better learning experiences by giving students access to real resources and delivering exploring lessons through interactive virtual environments [18]. McKinley School's VR success has encouraged other local schools to introduce the same program in their schools [52]. The technology shows how it can transform teaching methods in every subject area of the K-12 education system.

Case 6: Vocational training: Volkswagen's mechanic training

Volkswagen uses virtual reality to train apprentices in car maintenance operations. Trainees wear HTC Vive headsets to master their skills in repairing engines while diagnosing brake systems and electronics through virtual car models. The system without actual vehicles helps lower expenses and reduces training obstacles. The VR training program lets apprentices practice their work until they get better which builds their skill confidence [86]. Trainees get the chance to work with uncommon repair jobs beyond their everyday classroom curriculum. Volkswagen now saves training expenses and trainees perform better because of their VR education system success. After Volkswagen's VR success, other automotive producers are looking at adopting the same concept [86]. Virtual Reality delivers advanced training at reduced costs to develop technical abilities in firms that depend on practical learning methods.

6. THE APPLICATION OF VIRTUAL REALITY ACROSS EDUCATIONAL SCENARIOS

Educational use of virtual reality shows various outcomes at different learning levels with unique benefits and difficulties.

K-12 education

Schools across K-12 use virtual reality in STEM topics to make students feel more self-confident and motivated. Students can do safe practical experiments online through virtual laboratories which help them gain both practical skills and self-assurance. Students can use virtual tools to work with equipment and analyze experiments by changing laboratory conditions [19]. With VR students can directly interact with difficult scientific materials including how DNA appears and how ecosystems work using hands-on virtual experiences [66]. In mathematics, students can touch and work with geometric shapes and mathematical models because VR turns hard-to-grasp ideas into easy-to-see experiences [48]. The technique helps students better understand and value the lessons they learn [12]. VR enables students to visit digitally built versions of historic societies while watching important moments from the past which makes learning much more entertaining than printed text. Students use VR environments to train language skills through practical interactions with virtual realities [26]. Students practice French food orders while walking through Spanish streets in VR experiences. Through VR students of different learning styles including visual and kinaesthetic learners plus neurodiverse students find better focus in interactive training sessions.

Higher education

VR tools appear most often within medical, engineering, and architectural university programs. Through using VR, students access detailed simulations to learn practical skills that do not put them at risk in real life. Medical students use virtual simulation surgeries to develop both their self-assurance and ability ratings [1]. Engineering and architectural students learn better 3D modelling through VR to improve their problem-solving skills and understand challenging structures. VR tools help pre-service teachers learn classroom practices through real-life simulations before they start their work [13]. This training system helps teachers develop better skills while feeling more certain in their teaching.

General advantages and challenges

The review of research results shows VR provides valuable educational tools that let students explore simulated worlds and work well across different applications. Even though researchers have shown VR benefits, more studies require focus on these problem areas.

Cultural variability in the implementation and effectiveness of VR in education

Educational Virtual Reality technology functions in many different ways throughout the global world. For an educational system to use VR tools successfully these factors need to be considered: how each society understands technology shapes learning goals and how the simplicity of learning experiences helps students reach their educational objectives [68].

Cultural perceptions of technology in VR education

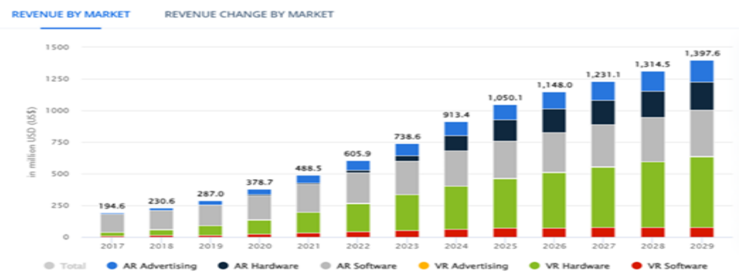

Figure 2: Forecasted revenue trend for AR and VR markets (Source: Panganiban et al. 2024)

The public's personal view about technology impacts the adoption of virtual reality programs in schools. South Korea and Japan lead the way to VR adoption since they strongly support innovation and digital transformation. More than 40% of South Korean schools use VR learning primarily for STEM subjects because national technology integration strategies promote this use [98]. The VR hardware and software markets keep expanding because more people and businesses invest in it [100]. Classrooms use VR to build real-looking labs and historical scenes which help students retain learning better than traditional methods. Several communities maintain reservations about using immersive technology [53]. Even though India and Brazil display increasing enthusiasm for digital teaching they still have an ongoing resistance against virtual reality tools [65]. Rural schools in India continue traditional teaching methods like memory repetition since only 10% of them test VR technology [35]. People doubt if immersive tech tools work properly in classroom settings because they do not trust technology enough and fear it will harm classical teaching traditions. Growing AR and VR markets show these technologies will succeed in education [5]. People need to adapt VR tools to different educational needs and overcome cultural challenges to fully use virtual reality technology at schools worldwide.

Comfort with immersive technology

Education institutions choose VR technology based on how well users feel comfortable in these environments. When hands-on learning methods dominate in America and Canada 60% of schools choose to use VR technology for better student interaction [15]. The majority of Japanese schools stick to traditional teaching because they prefer instructors delivering lessons [8]. People fear VR would reduce student discipline because they resist accepting these new learning tools so experts need to match VR technology to how teachers teach in different school settings [55].

Comparative analysis of VR adoption rates

The leading adoption of VR education tools in schools happens in North America and Europe thanks to official backing for interactive technology tools. The North American virtual reality education market expects to expand its business by 35% between 2022 and 2027 [104]. Available VR technology remains very confined in schools across sub-Saharan Africa because insufficient resources and poor networks limit its accessibility [54]. Proof of VR education's potential for STEM education comes from NGO and tech company-backed pilot programs in Kenya and South Africa [51]. Southeast Asia presents mixed results: Singapore's education institutions lead the region by reaching 30% VR adoption because of government-backed programs despite Indonesia and the Philippines continuing to struggle with accessibility issues when expanding VR usage [41].

The role of governmental and institutional support

How VR education will develop depends on public and organizational funding support. China leads the world by funding extensive VR educational applications to drive technological improvement. Chinese high schools will use VR-based learning environments starting in 2025 thanks to effective government backing. The minimal government support in Brazil and Mexico stops VR development from entering mainstream public schools where funding comes from outside sources [67]. Societies that support traditional educational values tend to oppose VR adoption because they fear it disrupts ingrained teaching practices. Many people cannot use VR because it costs too much [83]. Each Oculus Quest headset costs between $300 and $500 and it delivers a wireless VR experience without extra setup expenses which makes it affordable for schools with limited resources [93]. Mobile wireless systems let us install VR technology without facing setup problems in places that are remote or lack good resources [87]. Standalone VR devices lack sufficient power to produce intricate simulations used for advanced medical and engineering work. PC-tethered systems like HTC Vive give users better graphic display and faster output performance compared to standalone systems [41]. Users require these systems at $1,000 to $2,500 price points with both reliable high-speed network access and an uninterrupted electrical supply [59]. These systems work well for wealthy educational institutions yet they remain impossible to use for schools that lack basic technology funding in developing nations [99].

Figure 3: VR system in educational purpose (source: ixrlabs, 2024)

Standalone VR systems linked to PCs make virtual reality training difficult for schools with poor budgets. Basic VR systems allow many more learning institutions worldwide to add immersive experiences even when they have limited resources [9]. It is essential to solve the price problem of PC-tethered systems to help everyone get equal access [66]. Virtual Reality system development should focus more on reducing costs to make advanced simulation setups work for many schools [88]. School districts with more money can use PC-tethered systems but standalone VR solutions help reduce educational gaps for schools with limited funding. Officials from the government and educational organizations need to cooperate as VR advances to create access for students despite system costs [14]. Efforts should focus on lowering VR costs so students everywhere and everyone regardless of their economic status can benefit from improved educational experiences [59]. To succeed people, need focused investments in innovative products paired with equitable policies that let everyone use VR technology.

Table 1: **Conceptual framework**

Component	**Multi-Level Model**	**Cross-Cultural Research**	**Cost-Effect Analysis**
Description	Stage-specific VR use	VR in diverse contexts	Cost and impact studies
Challenges	Varied impact, ethics	Cultural differences	High costs, lack of data
Focus	Tailored applications	Expand global studies	Assess long-term feasibility

7. DISCUSSION

Virtual reality helps students in different learning spaces develop stronger academic self-confidence by using interactive learning methods [96]. Putting students in real-life virtual simulations helps them perform better at school and feel more capable as students [89]. This approach proves useful but researchers still need to understand its full capabilities and difficulties [94]. The use of VR in education needs additional research about how it affects students at different levels of learning and in different cultures as well as how VR affects student confidence over time [97].

Addressing educational contexts and cultural variability

Researchers usually focus their VR work on STEM subjects but find effective learning methods work across language studies, social sciences, and artistic subjects too. Research shows that what VR can deliver for education depends on either K-12 or higher education settings plus where it is used around the world. Societies where experiential learning is their typical educational method accept VR easily [22]. VR running into opposition happens in educational areas using conventional memorization learning instead of experience-based methods. Reports on how cultures and educational systems affect VR need to exist so people can design VR training that fits every student and setting [17].

Figure 4: AR application in biology classes (source: Microsoft, 2024)

Virtual reality delivers better results than other education methods because it creates realistic learning experiences. Learning with VR replaces outdated methods based on textbooks and audio tracks because students practice their target language in immersive real scenarios [26]. Through systems like MondlyVR and AltspaceVR students learn to speak and understand languages by visiting digital restaurants and cityscapes. When learners interact with each other through VR they develop better communication skills faster because the system provides instant feedback [95]. Scientists use VR to reproduce past events direct community research and investigate human behavior.

Students can explore historical sites through TimeLooper's virtual field trips which deliver memorable history lessons. Sociology learners use virtual spaces to examine group behaviours and observe relationships before they tackle larger societal problems [16]. Psychology students engage with VR content which displays psychological behaviours and teaches useful treatments, especially in exposure therapy for fear and Post Traumatic Stress Disorder. VR engagement delivers better learning results than classroom teaching methods with research showing students who use VR have a 25% improved knowledge gain [59].

Figure 5: Application of mixed reality (source: hitechlab, 2024)

The arts develop better through virtual reality technology. Learning tools Tilt Brush and Oculus Medium help visual arts students produce 3D artwork while developing strong spatial thinking and creative prowess. Students who study performing arts can practice their stage skills in digital theatres from StageCraft while music students can learn their instruments and compose tracks within the virtual space of Virtuoso [101]. Through Google Arts & Culture students can visit famous museums from home and explore artworks from around the world. Students can enter new creative worlds when they use VR art programs which break through regular classroom limits.

The need for longitudinal studies

Research shows VR boosts student participation and learning results temporarily but no studies exist to show what VR brings after extended use. The ongoing research needs to determine how VR changes mental growth along with how students remember what they learn and then put it to use in real life. The evidence suggests that VR technology can help students build new cognitive skills. Students use their whole self to explore and receive spatial information enabling them to develop core thinking skills. VR learning experiences produce better spatial awareness and thinking patterns for STEM students according to scientific reports. Most research only shows immediate VR impact on thinking skills while there is still a lack of data about whether these mental improvements stay strong over several years [91]. Specialists must study how VR affects student brain power as they advance through learning and begin their professional careers over extended periods. VR proved stronger than traditional learning systems at helping students remember what they learned. Research proves that VR learning methods help students remember information better than traditional teaching approaches. The findings reveal that VR students remembered 80% of their lessons one year later while students who studied from books retained just 50%. Research demonstrates that VR education maintains memory better because learners engage with virtual 3D content during the study. Future research needs to measure if VR students perform better academically over time, especially in math and science [81]. The value of VR training depends on how well students can use what they learn outside specific virtual environments especially when studying for work and further education. Education research proves students who receive VR training learn valuable skills better than traditional students when doing real-life tasks. Students who learned surgery with VR showed 30% enhanced effectiveness and precision in their operations. Ongoing research should examine how well VR skills stay with students after their training ends and become useful at work. Research will tell if VR can stay useful in education in the years ahead.

Emerging trends in VR, AR, and MR

VR's increased presence in education makes AR and MR technologies popular alongside it. These technologies enhance each other and create new ways for deep learning experiences. AR projects digital content onto surroundings so students can experience both reality and virtual components simultaneously. Students studying biology can now see human anatomy clearly through Google Lens whereas Merge Cube lets learners play with dimensional planet and historical object models. Students stay more interested and understand information better when they use these learning programs [61]. Users experience augmented reality and virtual reality environments through MR which lets them touch both physical and digital components. Students at medical schools study anatomy with Microsoft HoloLens because this device shows digital 3D models and real body systems during interactive lessons. By using zSpace students can work with 3D models across biology chemistry and engineering which raises their learning experience. Medical research proves that using mixed reality technologies helps students perform better by 30% and stay more involved during class time. By combining VR, AR and MR teaching approaches, it creates a complete educational platform. These learning tools work together to serve different student requirements [5]. Students learn more when AR highlights biological objects while VR shows interactive tours and MR lets users work with digital 3D models. By working together these technologies provide students with a better learning space that improves their memory of and their grasp of difficult subjects.

Cost and accessibility challenges

Current high technology costs prevent these systems from becoming standard in modern education. PC-tethered systems from HTC Vive deliver powerful simulation tools but schools with tight budgets cannot afford this equipment. These systems need both high-speed internet and continuous power delivery which makes them unusable in many educational settings. While Oculus Quest stands alone it features lower costs and better accessibility because it does not need comprehensive infrastructure. Because of their weak processor capacity, these devices cannot run sophisticated medical or engineering simulations [50]. Smartphones and tablets can run as AR accessories so these devices offer the easiest entry point to AR technology. These technologies work on regular school equipment which makes them usable for schools that have limited technology budgets. The expensive differences between VR AR and MR systems keep their benefits available only to schools with enough money to invest in advanced learning solutions. Efforts to bridge this gap are underway [39]. Companies such as zSpace sell mixed reality devices at reduced prices which connect to typical computers and Google helps people access virtual reality and augmented reality through low-cost Cardboard headsets. Educational institutions serving different income levels can now use these programs to bring VR technology into their courses.

Future integration and research

Research progress and technology implementation will reach VR's full potential once barriers to cost become easier to handle. VR and AR systems hosted in the cloud with 5G networking can make expensive hardware requirements unnecessary by letting schools purchase virtual content from a monthly provider. The introduction of AI technology into virtual reality learning environments helps us make better education for every student type. Research following a period of time is important to learn how VR affects learning and skill development permanently. Research findings will show educators how to create VR teaching materials and help make immersive education standards for schools everywhere. Using futuristic technology effectively can make VR AR and MR enhance how everyone learns better in school.

8. CONCLUSION

Virtual reality has the capacity to change education. Their designs are capable of providing immersive, engaging, and interactive experiences that exponentially improve how engaged, motivated as well as how effective students are in endless fields. The group of secondary and higher education has shown encouraging results in making complex, stoic topics more understandable and bettering experiential learning. As such, the research at hand has pinpointed vital areas in need of further study. As a relative advantage, the efficacy and scalability of VR rest precariously on the extent of adherence to ethical concerns, cultural variability, and long-term effects. If institutions want to capitalize on VRs while upholding their ethics, they must be willing to adhere to certain ethical hindrances such as data privacy, potential psychological effects, and the advent of heavy reliance on technology. Effective implementation whose VICE responsibility model includes creating specific privacy frameworks, shaping the length of exposure, and validating that VR sharpens the user's sense of learning, does not serve as a poor substitute. Trends such as AR or augmented reality add to the explanatory and experientially rich environment of education and enable the creation of new hybridised educational elements. Future research endeavours will focus on creating affordable virtual reality technologies for use in disadvantaged areas while continuing research on the long-term effects on cognition, memory, and skill. As one of the new leaders, EarlyLee has made it one of their goals to make these devices accessible to the educationally disadvantaged. If small-scale studies are perfected and these global deficits get resolved, VR has fulfilled its massive ambition of providing a worldwide foundation for learning in all its forms for all individuals regardless of culture and socioeconomic background.

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