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IMPACT OF VIRTUAL REALITY (VR) AND AUGMENTED REALITY (AR) ON STUDENT ENGAGEMENT AND ACADEMIC ACTIVITIES IN BLENDED LEARNING ENVIRONMENTS IN OGUN STATE TERTIARY INSTITUTION

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Abstract
The integration of Virtual Reality (VR) and Augmented Reality (AR) in education has emerged as a transformative approach within blended learning environments. This study examined the influence of VR and AR technologies on student engagement, academic effectiveness, and learning outcomes in blended learning environments. Using a descriptive survey research design, the study was conducted among 330 undergraduates in Tai Solarin University of Education. Data were collected through a structured questionnaire and analyzed using descriptive statistics. Findings revealed that students generally perceive VR and AR as engaging and interactive learning tools ($\bar{x}$ = 3.06). VR and AR also enhance academic performance and comprehension of complex concepts ($\bar{x}$ = 3.04). However, key challenges to their integration include high costs, inadequate technical support, and infrastructure limitations ($\bar{x}$ = 3.00). Additionally, while many students appreciate VR and AR, some still prefer traditional learning methods due to ease of use and familiarity ($\bar{x}$ = 2.94). The study concluded that VR and AR positively impact student engagement and academic performance, but financial and technical constraints hinder their widespread adoption. It recommends increased institutional investment, teacher training, and student digital literacy programs to maximize the potential of VR and AR in education.

Keywords: VR and AR, Blended Learning, Student Engagement, Academic Activities

1.0 Introduction

Blended learning, which describes an approach to education that weaves together traditional in-person teaching with online learning, has seen considerable growth over the years. The concept emerged as educators sought innovative ways to improve learning outcomes by leveraging technology alongside conventional teaching methods. Initially, blended learning was primarily about supplementing in-class instruction with online resources, but it has since evolved to include more interactive activities, real-time virtual engagement, and personalized

learning experiences (Shurygin *et al.*, 2024). In the modern educational landscape, the integration of digital tools and technologies has become a key feature of blended learning environments (Xiao *et al.*, 2024). The benefits of blending traditional and digital methods include fostering student autonomy, improving learning efficiency, and catering to a wide range of learning preferences (Agbo *et al.*, 2021). The concept of student engagement is associated with the extent of their interest, zeal and commitment towards learning experiences (Jeong *et al.*, 2019). It is a crucial factor in determining the success of educational programs, as higher engagement is often associated with improved academic performance, better retention of knowledge, and increased motivation to learn (Norazura & Fariza, 2024). In the context of blended learning, student engagement plays an even more significant role. With the combination of online and face-to-face learning environments, students may experience varying levels of interaction and support, which can affect their engagement. As such, finding ways to sustain and enhance engagement, especially in online components, is critical. Engaging students in a blended learning environment not only improves their academic outcomes but also prepares them for future challenges in a digitally-driven world (Akhmetshin *et al.*, 2023).

AR, while less immersive than VR, allows for interactive learning by providing additional context and information directly within the student's view of the physical world. Both technologies are seen as transformative in education (Dhimolea *et al.*, 2022). VR, with its ability to simulate complex environments, allows students to experience real-life situations and challenges. VR can be used in medical education to allow students to practice surgeries or in history lessons to transport students back in time (Xiao *et al.*, 2024). Moreover, VR and AR promote experiential learning, an approach where students learn through direct experience. This hands-on learning process is particularly effective in fields where practical application of knowledge is crucial, such as in engineering, medicine, and the arts. The interactive nature of VR and AR ensures that students are not mere observers but active participants, which greatly enhances their overall engagement (Amir *et al.*, 2024). Technology integration in these environments facilitates more dynamic and flexible learning experiences, allowing for individualized instruction and the development of critical skills such as problem-solving, collaboration, and digital literacy. However, there are several use cases of blending VR and AR for the same in the blended learning environments. The second allows students the freedom of being able to learn topics on their own time and from their own perspective, whether for physics or other classes that may be offered in either a physical classroom environment or through online settings. Moreover, technology-enhanced learning fosters a more interactive and student-centered approach to education, where learners are encouraged to take responsibility for their own learning (Norazura & Fariza, 2024).

However, integrating these technologies into blended learning environments also presents challenges. Teachers must be adequately trained in using these tools, and it becomes

imperative for institutions to invest in the necessary infrastructure and support systems (Adedokun *et al.*, 2023). Additionally, while VR and AR hold immense potential for enhancing engagement, their successful implementation depends on their effective integration into the curriculum and their ability to align with students' learning objectives (Shurygin *et al.*, 2024). Hence, it is therefore imperative to evaluate the impact of VR and AR on student engagement and academic activities in blended learning environments. Specifically, the objectives of the study are:

(i) To assess the influence of VR and AR technologies on student engagement in blended learning environments;
(ii) To examine the impact of VR and AR on the effectiveness of academic activities and learning outcomes in blended learning environments;
(iii) To identify the challenges and barriers faced by students and instructors in incorporating VR and AR into blended learning;
(iv) To explore students' perceptions and attitudes towards the use of VR and AR in blended learning environments.

1.1 Overview of VR and AR in Education

Virtual Reality and Augmented Reality technologies enable learners to interact with digital content in a way that was previously impossible through traditional learning methods (Poux *et al.*, 2020). According to Radianti *et al.* (2020) VR is defined as a computer-generated environment that simulates real world experiences and AR is overlaying the digital element into physical world. This technology can have different applications in the fields of healthcare, engineering, history and education in art. They provide opportunities for immersive learning experiences that can facilitate deep engagement and retention of knowledge (Makransky & Petersen, 2021). In particular, VR allows for full immersion into a digital world, which is beneficial for complex subjects such as medical training and simulations (Pottle, 2019). Together, VR and AR are enabling educators to move beyond the traditional classroom setup, allowing for virtual field trips, interactive simulations, and collaborative activities, which can cater to various styles of learning as well as preferences (Poux *et al.*, 2020). Both VR and AR technologies serve as powerful tools in enhancing engagement and interaction in learning environments. VR, through its immersive nature, can transport students to distant locations or microscopic worlds, making learning experiences more vivid and relatable (Makransky, Terkildsen, & Mayer, 2019). For example, medical students can practice surgeries in a virtual environment, or history students can explore ancient civilizations through virtual tours. These experiences foster deeper cognitive engagement by enabling learners to 'experience' rather than simply read about information, making complex concepts easier to grasp. Similarly, AR is gaining popularity for its ability to augment real-world experiences. It can transform ordinary textbooks or environments into interactive learning tools, enriching traditional materials with digital overlays. This technology is particularly effective in subjects that require

spatial understanding, such as engineering and architecture, where AR can display 3D models of buildings or machinery (Alajmi, 2021).

According to Rzanova *et al.* (2023), the use of AR in engineering education has shown significant improvements in students' competencies, especially in terms of visualization and problem-solving skills. Furthermore, AR's ability to provide real-time data and annotations on objects or environments enhances the learning process. The integration of VR and AR into the learning process has also been shown to significantly impact student engagement. In this context, engagement describes how interested, excited, and involved students are in the learning process (Alajmi, 2021). By immersing students in interactive virtual worlds or enhancing their physical surroundings with digital information, these technologies stimulate both cognitive and emotional responses, which are essential for maintaining interest and improving retention (Makransky & Petersen, 2021). Moreover, VR and AR offer unique opportunities for experiential learning. As explained by Al-Said *et al.* (2023), experiential learning emphasizes learning through experience rather than passive reception. VR simulations in fields like architecture allow students to design and walk through their own creations, providing a more holistic understanding of spatial design. In a similar vein, AR applications in science education can allow students to manipulate virtual molecules and observe chemical reactions in real-time. Moreover, VR and AR can also foster collaborative learning. With the rise of blended learning environments, where digital and face-to-face learning methods are combined, these technologies provide a platform for students to interact with each other in both virtual and physical spaces. Students can collaborate on virtual projects, participate in simulated group activities, or even engage with peers from different geographical locations, thus enhancing their teamwork and communication skills. Such collaboration is vital in modern education, where digital literacy and teamwork are critical for success in the workforce (Pirker & Dengel, 2021).

For many educational institutions, especially in developing countries, the financial investment required for setting up VR and AR labs can be prohibitive (Alajmi, 2021). Additionally, there is a need for teacher training to ensure educators are equipped to effectively integrate these technologies into their teaching methods (Pirker &Dengel, 2021). As noted by Pottle (2019), without proper training, the use of VR and AR can become ineffective or even overwhelming for both teachers and students. Moreover, the use of VR and AR in education requires a robust technological infrastructure. In particular, stable internet connections, high-quality headsets, and compatible devices are essential for providing a seamless learning experience; this can present a challenge in areas where access to such technologies is limited or inconsistent.

1.2 Impact of VR and AR on Student Engagement

The integration of these immersive technologies into the learning process is transforming traditional educational methods and practices, providing more engaging and

interactive; these technologies are particularly influential in blended learning environments, where students engage with both online and face-to-face learning modes. VR and AR technologies support the development of skills, increase student motivation, and enhance their overall academic engagement by offering new opportunities for visual and experiential learning. VR provides an immersive experience by creating a virtual environment where students can interact with objects and scenarios in a way that mimics real-life experiences (Pirker &Dengel, 2021). Similarly, AR overlays digital content in the physical environment, allowing students to interact with augmented learning materials; this interactivity fosters deeper engagement by enabling students to manipulate and explore content actively, rather than passively receiving information (Yuan & Wang, 2021). The use of VR and AR also enhances visual learning, an essential mode of learning for many students. Visual learning aids, such as images, diagrams, and videos, have long been known to improve comprehension and retention (Skulmowski *et al.*, 2021). VR takes this to the next level by offering 360-degree environments where students can observe and interact with subjects from all angles. This spatial and immersive experience promotes better understanding of complex topics, such as geography or anatomy, by providing a more vivid, lifelike representation than traditional methods (Makransky *et al.*, 2019).

In similar vein, AR improves visual learning by embedding digital elements into the physical world, allowing students to visualize and manipulate abstract concepts. For instance, AR can bring static diagrams to life, transforming them into interactive 3D models, which can enhance students' grasp of intricate scientific concepts (Poux *et al.*, 2020). Experiential learning allows students to develop a deeper understanding of concepts by actively engaging with them in real-world contexts. With VR, students can participate in simulations that mimic real-life experiences, such as virtual field trips to historical sites or environmental ecosystems (Radianti *et al.*, 2020). Similarly, AR can augment practical experiences by providing real-time data or instructions that support learning on the go (Pottle, 2019). VR simulations can be adapted to different learning levels, providing more challenging tasks for advanced students and simpler tasks for those who need more support. AR, too, supports personalized learning by offering contextualized information that is relevant to the student's current location or activity, making learning more meaningful and applicable. This ability to tailor learning experiences helps increase motivation and engagement, as students feel more in control of their learning journey (Makransky& Petersen, 2021).

Furthermore, VR and AR have been shown to increase student motivation by making learning more enjoyable and less intimidating. Virtual Reality's ability to fully absorb users gives students the sensation of truly being in the learning environment; this feeling of "being there" can help ease their anxiety and boost their motivation (Tsivitanidou *et al.*, 2021). Students can explore difficult subjects in a non-threatening and enjoyable manner, which can be particularly helpful in subjects that students

may otherwise find intimidating, such as mathematics or foreign languages (Song *et al.*, 2023). The playful nature of AR, with its interactive and gamified elements, further enhances motivation by introducing fun and competition into the learning process. As students engage with AR apps, they are more likely to invest time and effort into learning, thereby improving both engagement and learning outcomes. The ability of VR and AR to increase student engagement is particularly evident in their role in blended learning environments (Alajmi, 2021). These technologies bridge the gap between online learning and in-person instruction by creating interactive, engaging, and immersive experiences that enhance the overall educational experience. In a blended learning setting, students can use VR to participate in virtual simulations at home, and then discuss and reflect on these experiences during in-person classes (Sun & Peng, 2020).

2.0 METHOD

2.1 Research Design

A descriptive survey research methodology was adopted for this study.

2.2 Population of the Study

The population for this study comprised of all undergraduate students at Tai Solarin University of Education (TASUED) in Ijagun, Ogun State, Nigeria.

2.3 Sampling Technique and Sample

Stratified random sampling technique was employed to select the sample for the study. Stratified sampling ensured that the sample represented all six colleges at TASUED, while simple random sampling was used within each college to select the respondents. The sample size was determined to be 1% of the total undergraduate student population across the six colleges, resulting in a sample of 330 students. The distribution of the sample is shown in the table below:

Table 1: Distribution of Sample

S/N	Colleges	Population	Sample (1%)
1	COSMAS	7,299	73
2	COSPED	5,613	56
3	COAHM	363	4
4	COVTED	8,889	89
5	COSIT	4,420	44
6	COHUM	6,406	64
Total		**32,990**	**330**

2.3 Research Instrument

The primary data collection tool was a self-designed, close-ended questionnaire.

2.3.1 Reliability of Research Instrument

To assess the reliability of the instrument, a trial test was conducted with a subset of respondents from Olabisi Onabanjo University. A total of 20 questionnaires were

distributed, and the responses were divided into two groups (even and odd numbered items). Split half was then calculated to determine the consistency of the instrument. The reliability coefficient (0.91) was obtained from this analysis which confirmed the instrument is reliable for the study.

2.4 Procedure for Data Collection

Data collection took place over a five-day period, during which the researcher administered the questionnaires to the undergraduate students of TASUED. Prior to data collection, the researcher obtained necessary permissions from the institution's authorities and explained the purpose and significance of the study to the respondents. After distributing the questionnaires, the researcher collected them immediately upon completion. The research was conducted with ethical considerations, ensuring confidentiality and voluntary participation.

2.5 Method of Data Analysis

The data gathered from the questionnaires were analyzed using descriptive statistics including frequency counts, percentage, mean and standard deviation.

3.0 RESULTS AND DISCUSSION

RQ 1: What is the influence of VR and AR on student engagement?

Table 2: Descriptive Analysis of the Influence of VR and AR on Student Engagement

S/N	Items	SA (Freq. %)	A (Freq. %)	D (Freq. %)	SD (Freq. %)	Mean	Std. Dev.
1	I find VR and AR technologies improve my level of engagement in class.	98 (29.7%)	124 (37.6%)	72 (21.8%)	36 (10.9%)	3.06	1.05
2	VR and AR technologies make learning activities more interactive.	112 (33.9%)	130 (39.4%)	60 (18.2%)	28 (8.5%)	3.08	0.98
3	Using VR and AR in class helps me focus better on academic tasks.	110 (33.3%)	120 (36.4%)	66 (20.0%)	34 (10.3%)	3.03	1.03
4	The use of VR and AR increases my motivation to participate in lessons.	115 (34.8%)	126 (38.2%)	55 (16.7%)	34 (10.3%)	3.08	1.00
5	VR and AR technologies enhance my understanding of complex academic concepts.	108 (32.7%)	122 (37.0%)	60 (18.2%)	40 (12.1%)	3.04	1.01
	Average Mean					**3.06**	**1.01**

The results show that VR and AR technologies have a moderate to high impact on student engagement in blended learning environments. Item 1 (mean = 3.06) indicates that most respondents agree that VR and AR improve engagement, with a substantial proportion of students finding these technologies helpful in increasing interactivity (mean = 3.08). Similarly, items 3 and 4 reflect that VR and AR foster better focus and motivation for students (mean = 3.03 and 3.08, respectively). The average mean of 3.06 suggests that overall, students perceive VR and AR as beneficial for enhancing both engagement and understanding in academic activities within blended learning settings.

RQ 2: What is the impact of VR and AR on academic effectiveness and learning outcomes?

Table 3: Descriptive Analysis of the Impact of VR and AR on Academic Effectiveness and Learning Outcomes

S/N	Items	SA (Freq. %)	A (Freq. %)	D (Freq. %)	SD (Freq. %)	Mean	Std. Dev.
1	VR and AR technologies improve my academic performance in blended learning environments.	90 (27.3%)	140 (42.4%)	65 (19.7%)	35 (10.6%)	2.87	1.05
2	VR and AR tools help me to better understand complex academic concepts.	135 (40.9%)	110 (33.3%)	65 (19.7%)	20 (6.1%)	3.09	0.98
3	VR and AR technologies make academic tasks more engaging and enjoyable.	160 (48.5%)	100 (30.3%)	50 (15.2%)	20 (6.1%)	3.18	1.03
4	The use of VR and AR enhances my learning outcomes in blended learning environments.	120 (36.4%)	125 (37.9%)	55 (16.7%)	30 (9.1%)	3.05	1.02
5	I retain information better when VR and AR are integrated into academic activities.	110 (33.3%)	145 (43.9%)	50 (15.2%)	25 (7.6%)	3.02	1.04
	Average Mean					**3.04**	**1.02**

Table 3 shows the impact of VR and AR on academic effectiveness and learning outcomes and the result of item 1 (Mean = 2.87) shows a slightly lower score, indicating

that while a majority agree that VR and AR improve academic performance, it is not as strongly endorsed as other aspects.Item 2 (Mean = 3.09) indicates stronger agreement that VR and AR tools help students understand complex concepts.Item 3 (Mean = 3.18) is the highest, reflecting that students find VR and AR the most engaging and enjoyable for academic tasks.Item 4 (Mean = 3.05) suggests that the integration of VR and AR positively impacts learning outcomes, but not as strongly as the engagement factor.Item 5 (Mean = 3.02) shows that students retain information better with VR and AR integration, though not as strongly as other items.

The average mean of 3.04 indicates a generally positive perception of VR and AR's impact on academic activities and learning outcomes.

RQ 3: What are the challenges and barriers in incorporating VR and AR into blended learning?

Table 4: Descriptive Analysis of Challenges and Barriers in Incorporating VR and AR into Blended Learning

S/N	Items	SA (Freq. %)	A (Freq. %)	D (Freq. %)	SD (Freq. %)	Mean	Std. Dev.
1	The cost of acquiring VR and AR technologies is a major barrier to their integration into blended learning.	115 (34.8%)	155 (47.0%)	40 (12.1%)	20 (6.1%)	3.11	0.98
2	Lack of adequate technical support and training for instructors hinders the effective use of VR and AR.	125 (37.9%)	130 (39.4%)	50 (15.2%)	25 (7.6%)	3.06	1.02
3	Students find VR and AR technologies difficult to use, which limits their engagement.	80 (24.2%)	120 (36.4%)	90 (27.3%)	40 (12.1%)	2.73	1.04
4	There is insufficient infrastructure (e.g., devices, internet speed) to effectively use VR and AR in learning.	140 (42.4%)	105 (31.8%)	55 (16.7%)	30 (9.1%)	3.08	1.07
5	There is resistance from both instructors and students towards adopting new technologies like VR and AR.	100 (30.3%)	160 (48.5%)	45 (13.6%)	25 (7.6%)	2.97	1.03
	Average Mean					**3.00**	**1.03**

The result of table 4 shows the challenges and barriers in incorporating VR and AR into blended learning. Item 1 (Mean = 3.11): Majority of the respondents strongly agree or agree that the cost of acquiring VR and AR technologies is a major barrier. Item 2 (Mean = 3.06): There is a strong recognition that the lack of adequate technical support and training for instructors limits the effective use of VR and AR. Item 3 (Mean = 2.73): While some students find VR and AR difficult to use. Item 4 (Mean = 3.08): Insufficient infrastructure, such as devices and internet speed, is another notable challenge. Item 5 (Mean = 2.97): Resistance to adopting new technologies is a common barrier, but the mean is not as high. The average mean of 3.00 indicates that, the major challenges and barriers in incorporating VR and AR into blended learning are related to cost, technical support, infrastructure and resistance to change.

RQ 4: What are the students' perceptions and attitudes towards VR and AR in blended learning?

Table 5: Descriptive Analysis of Students' Perceptions and Attitudes Towards VR and AR in Blended Learning

S/N	Items	SA (Freq. %)	A (Freq. %)	D (Freq. %)	SD (Freq. %)	Mean	Std. Dev.
1	VR and AR make learning more interactive and engaging.	135 (40.9%)	115 (34.8%)	50 (15.2%)	30 (9.1%)	3.08	1.05
2	Using VR and AR in learning makes it easier to understand complex concepts.	120 (36.4%)	110 (33.3%)	60 (18.2%)	40 (12.1%)	2.94	1.07
3	VR and AR technologies improve my motivation to participate in class activities.	140 (42.4%)	90 (27.3%)	60 (18.2%)	40 (12.1%)	3.00	1.09
4	I feel more comfortable using traditional learning methods than VR and AR.	95 (28.8%)	100 (30.3%)	75 (22.7%)	60 (18.2%)	2.70	1.10
5	Frequent use of VR and AR in learning environments will significantly improve academic performance.	130 (39.4%)	105 (31.8%)	55 (16.7%)	40 (12.1%)	3.00	1.06
	Average Mean					**2.94**	**1.07**

Table 5 shows students' perceptions and attitudes towards VR and AR in blended learning. Item 1 (Mean = 3.08): A majority of students strongly agree or agree that VR and AR make learning more interactive and engaging.Item 2 (Mean = 2.94): Students recognize that VR and AR simplify complex concepts. Item 3 (Mean = 3.00): Motivation to participate in class activities increases with the use of VR and AR. Item 4 (Mean = 2.70): A significant proportion of students prefer traditional learning methods over VR and AR. Item 5 (Mean = 3.00): Students believe that regular use of VR and AR could enhance academic performance. The average mean of 2.94 suggests that while students generally perceive VR and AR positively, some reservations exist, particularly regarding preference for traditional methods and varying degrees of perceived effectiveness in improving academic engagement.

3.1 Discussion of results

The study revealed that students perceive VR and AR as beneficial for enhancing both engagement and understanding in academic activities within blended learning settings. This finding aligns with the study of Makransky and Petersen (2021), who asserted that VR and AR facilitate deep engagement and knowledge retention by offering immersive and interactive learning experiences. Their research demonstrated that students who engage with VR-based learning environments exhibit higher levels of enthusiasm and concentration compared to traditional learning methods. Similarly, Poux *et al.* (2020) emphasized that the ability of VR and AR to provide experiential and context-based learning significantly improves students' comprehension of complex subjects.

The study revealed that there is significant impact of VR and AR on academic activities and learning outcomes. This finding aligns with the study of Radianti *et al.* (2020), who asserted that VR and AR enhance students' academic performance by providing an immersive learning environment that fosters deeper engagement and retention. Their study found that students exposed to VR simulations demonstrated better comprehension and practical application of knowledge compared to those using conventional learning methods. Similarly, Makransky *et al.* (2019) emphasized that VR-based education improves students' conceptual understanding, particularly in scientific and technical disciplines, by allowing them to experience and manipulate virtual objects and environments. Additionally, Pottle (2019) highlighted that VR's ability to replicate real-world scenarios is particularly beneficial for skill-based training, such as in medical and engineering education. Their study demonstrated that medical students who practiced procedures in a VR environment performed significantly better in real-life clinical settings than those trained using traditional methods. This further supports the assertion that VR and AR positively influence learning outcomes by bridging the gap between theoretical knowledge and practical application.

The study showed that the major challenges and barriers in incorporating VR and AR into blended learning are related to cost, technical support, infrastructure and resistance to change. This finding aligns with the study of

Alajmi (2021), who asserted that the high cost of VR and AR equipment and software is a major limitation to their widespread adoption in educational settings. Their research found that many institutions, particularly in developing regions, struggle to integrate these technologies due to financial constraints. Beyond hardware costs, additional expenses related to software updates, maintenance, and digital content creation further hinder large-scale implementation. Similarly, Reddy *et al.* (2020) emphasized that inadequate technological infrastructure, including unstable internet connections and incompatible devices, poses significant barriers to the effective use of VR and AR in blended learning environments.

The study showed while students generally perceive VR and AR positively, some reservations exist, particularly regarding preference for traditional methods and varying degrees of perceived effectiveness in improving academic engagement. This finding aligns with the study of Skulmowski *et al.* (2021), who asserted that while VR and AR enhance student engagement, some learners still prefer traditional instructional methods due to familiarity and ease of use. Their research indicated that students accustomed to conventional learning approaches may find VR and AR initially overwhelming or distracting, leading to mixed perceptions of their effectiveness. Similarly, Yuan and Wang (2021) found that not all students equally benefit from VR and AR technologies, as some struggle with adapting to immersive learning environments, particularly those who are not tech-savvy.

4.0 Conclusion

In conclusion students perceive Virtual Reality (VR) and Augmented Reality (AR)technologies positively due to their immersive and interactive nature, which aligns with previous research indicating improved knowledge retention and problem-solving skills. VR and AR are shown to have a substantial impact on academic performance, particularly in disciplines requiring practical applications, such as medicine and engineering. The ability of VR to replicate real-world scenarios and AR's capacity to overlay digital models onto physical environments facilitate deeper understanding and conceptual mastery. Despite these benefits, the study also identifies critical challenges that hinder the widespread adoption of VR and AR in educational institutions. Financial constraints related to the acquisition and maintenance of VR and AR technologies remain a major barrier, particularly in resource-limited settings. Inadequate technological infrastructure, resistance to change among educators, and the need for comprehensive training further complicate implementation. Additionally, while students generally have a favorable view of VR and AR, some express a preference for traditional learning methods, citing concerns over adaptability and effectiveness in non-practical subjects.

Recommendations

In view of the findings, the following recommendations were suggested:

- **Educational institutions should** allocate funding for VR and AR

technologies to enhance accessibility and integration into blended learning.

- **Government policymakers should develop** policies and grant programs to support the adoption of VR and AR in educational institutions, particularly in underfunded schools.
- **Educators should** undergo continuous training on VR and AR tools to effectively integrate them into pedagogical practices.
- **Technology developers should** design cost-effective and user-friendly VR and AR solutions tailored for diverse academic disciplines and student needs.
- **Students should** engage in workshops and training sessions to develop digital literacy skills required for maximizing VR and AR learning benefits.
- **Researchers should** conduct longitudinal studies to evaluate the long-term effectiveness of VR and AR in enhancing student learning outcomes across various educational contexts.

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