

Review Article

Emerging Technology Utilization in the Omani Higher Education: Progress, Challenges, Future and Recommendations

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Abstract - This study provides in-depth overview of the current literature into the adoption of emerging technologies such as Virtual Reality (VR), Augmented Reality (AR), and the Metaverse into higher education institutions in Oman in 2020-2025. The aim of the research is to develop the existing trends, theories and issues that affect the adoption of such technologies in learning and teaching situations. The systematic review methodology has been used to analyze eleven peer-reviewed articles carried out in Oman. The results indicate a gradual increase in academic interest, as the investigations are more exploratory in 2022, and by 2025, there is more institutionalized interest. Technology Acceptance Model (TAM) became the most popular theoretical model, and it is followed by the Unified Theory of Acceptance and Use of Technology (UTAUT) and Technological Pedagogical Content Knowledge (TPACK) model. The study of the researches was able to identify recurrent challenges in four major categories, namely, technical, training and skills, financial, and institutional. The most outstanding ones are difficulties in access to VR/AR devices, deficient training of the pedagogue, expensive gadgets, and ineffective policy endorsement. Overall, the research paper finds that the higher education sector in Oman is developing in the direction of enhanced technological preparedness, but the systemic limitations still prevent the implementation on a large scale. To overcome these challenges, national coordination, capacity building through investment and development of pedagogically congruent content, is needed to guarantee long-term adoption of emerging technologies in education.

Keywords - Emerging technology, Virtual Reality, Augmented Reality, Metaverse, Artificial Intelligence.

1. Introduction

The recent years have seen the emergence of novel technologies like Virtual Reality (VR), Augmented Reality (AR), Artificial Intelligence (AI), 3D holography, and immersive simulations that have begun reshaping higher education across the world [1]. The novel technologies offer new ways of improving instruction, learning, and research through immersion in new experiences, interactive content delivery, and personalized learning environments [2, 3]. Universities across the world have been embracing digital transformation strategies to prepare graduates to meet the demands of fast-evolving industries that need creativity, digital literacy, and critical thinking [4]. Oman's use of new technologies in education is aligned with Oman's Vision 2040, which emphasizes innovation, knowledge economies, and sustainable development [5]. Oman's universities and colleges have progressed substantially in the use of online learning platforms, virtual laboratory simulation, and AR/VR-based teaching pedagogies, particularly for fields such as

engineering, architecture, health sciences, and teacher education [3]. Policies of the government, institutional partnerships, and growing research interest have all contributed to foster a favorable climate for digital transformation within academia.

Nevertheless, despite these developments, there are still some issues that are significant. First, the majority of the tertiary learning institutions are limited by infrastructural technology, staff preparedness, installation expenses, and the need to develop indigenous digital content. Others include the difference in institutional policies, lecturing staff digital literacy, as well as the lack of empirical evidence on the effectiveness of the technologies [6-8]. There is, therefore, a critical need to formulate guidelines that will ensure the accessibility, inclusiveness, and cultural suitability of these technologies in the Omani educational context. While new technologies like VR, AR, AI and the Metaverse are increasingly garnering interest around the world in higher



education research, studies conducted in the Sultanate of Oman appear scattered across various education sectors and institutions. Earlier studies mainly focused on certain technologies or education context isolation, and they didn't provide a detailed exploring about the research trends, theory, implementation, institution and methods. Various global systematic reviews on immersive technologies in higher education have been conducted, but they mostly take a global view, with few focusing on the context in country-specific systems of education.

Additionally, a thorough systematic review has yet to be produced regarding the issue of the adoption of emerging technology in Omani higher education between 2020 and 2025. As such, this study fills an important gap in the literature of a systematic review of empirical evidence relating to VR, AR, AI and Metaverse in Omani higher education.

In contrast to prior reviews, the current paper synthesizes technology-related trends, theoretical models, research methodologies, institutional contributions, implementation barriers, and future research priorities to generate a meaningful roadmap for researchers, institutions, and policymakers. This review is the first of its kind to create an integrated synthesis of emerging technology research in the Omani higher education space while proposing strategies.

2. Literature Review

Employing Technologies in the Tertiary Education System Emerging technologies are changing the higher education landscape by creating more interactive, personalized, and student-centred learning environments. AI, VR, AR, MR, Metaverse, and Extended Reality (XR) are increasingly being integrated into Teaching, Learning, Assessment and academic administration. These technologies foster pioneering education approaches participate students improve learning outcomes, and equip graduates with the digital skills required for the fourth and fifth industrial revolutions.

2.1. Intelligent Agent Software

The higher education sector has benefited greatly due to the impact of Artificial Intelligence. AI systems make possible personalized learning, intelligent tutoring, automated assessment, adaptive learning pathways, learning analytics and prediction of student performance. With real-time feedback and predictive intervention for at-risk students, AI also helps ease instructors' administrative burden. Additionally, generative AI tools develop content for research, collaborative learning, and more, making education efficient and accessible.

Augmented Reality referred to the technology that helps create a connection between the digital world and the physical world. Augmented Reality helps students make their own

virtual objects that are more contextualized to see their interactivity and behavior. In higher education, AR finds application in science, engineering, healthcare and technical education to reinforce different concepts and facilitate hands-on learning experience. Combining Realities Mixed Reality (MR) brings together aspects of Virtual and Augmented Reality so that both digital and physical objects can exist in the same space. MR is not just VR or AR alone, but MR allows users to manipulate virtual objects in real-world environments.

In higher education, MR provides environments for students to collaborate and experiment or solve problems through laboratory simulations, engineering design, architectural visualization and more. Metaverse Users engage in acts of communication in the metaverse via digital avatars that occupy common virtual settings.

The Metaverse in higher education offers the prospects of virtual classrooms, collaborative learning, virtual laboratories, remote instruction, and immersive experiences. Through the deployment of immersive technologies, blockchain, digital twins, and AI, the Metaverse facilitates interaction in learning process.

3. Methodology

The objective of the review is to answer three research questions: 1) What are the major drivers of Emerging Technology use in the Omani higher education? 2) What is the present position of the Emerging Technology in many higher educations? 3) What are the obstacles in implementing Emerging Technology in the Omani higher education? 4) and What future and recommendations can be made regarding the Emerging Technology in the Omani higher education. To investigate the study questions, the review has followed the guidelines of Preferred Reporting Items of Systematic Reviews and Meta-Analyses (PRISMA), as defined by Moher, Liberati, Tetzlaff, Altman, and Group (2009) (see Figure1).

The methodical approach involved four stages, that is, identification, screening, eligibility and inclusion. In the identification phase, study used internet databases to search and identify some articles. During the screening stage, the study selected the articles by eliminating duplicates. The eligibility phase included assessments and the elimination of the articles that did not support the context of this study.

Lastly, the inclusion phase was done to choose articles to undergo the final analysis. Search strategy: The PRISMA principles dictated that we performed a multidisciplinary search of the existing studies to address the research questions above. We have searched a number of databases, such as Web of Science, Google scholarship, PubMed, Scopus, IEEE, and Science Direct. Also, the reference lists of all the selected papers were reviewed to locate more relevant studies.

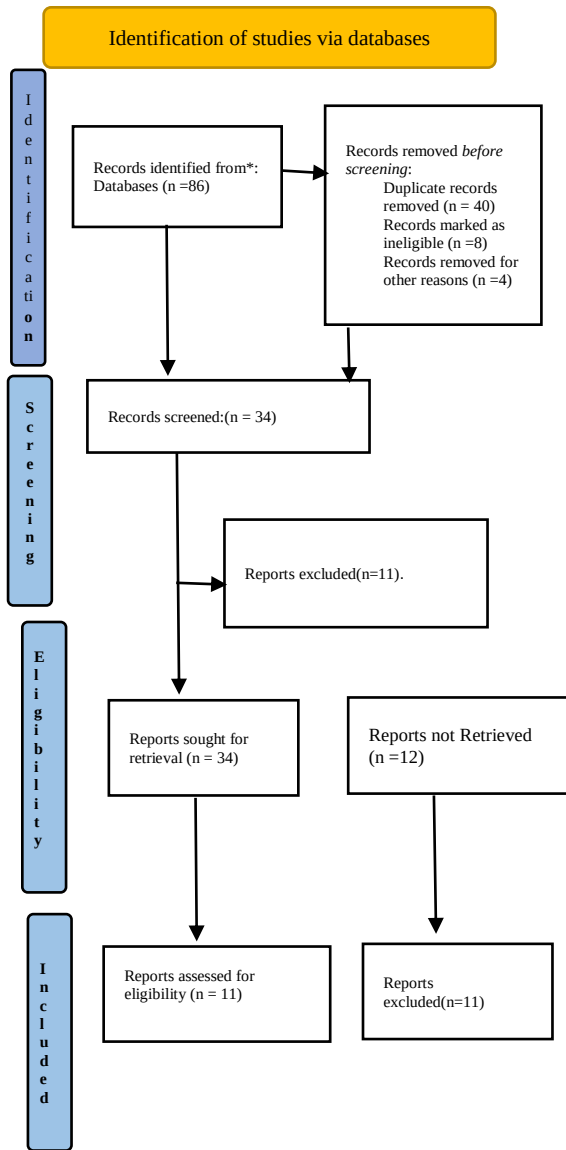


Fig 1. PRISMA stages

3.1. Search Terms

This study utilized several search spaces for discovery the correlated literature. The typical words used included ‘adopting Emerging technology in Oman OR ‘Emerging technology applications adoption in Oman OR ‘Artificial Intelligence in Oman OR “hologram” OR ‘artificial intelligence’ OR “Virtual reality” OR “Augmented reality”, ‘OR ‘Emerging technology systems in Oman OR ‘Emerging technology services in Oman.’ These terms were selected because they are commonly used in discussions and research related to emerging and cutting-edge technologies. To ensure that the collected studies were relevant to the research objectives, specific inclusion and exclusion criteria were carefully applied. The selected articles were then reviewed and organized based on their relevance and contribution to the study. Microsoft Excel was used to organize, categorize, and

manage the collected articles in a systematic manner. This process helped maintain consistency throughout the review and made it easier to identify relevant information. It also allowed the researchers to keep track of the selected studies and compare their key characteristics. Particular attention was given to ensuring that the included articles directly addressed the main focus of the research. Overall, this approach provided a clear and organized basis for analyzing the available literature.

3.2. Inclusion and Exclusion Criteria

The researchers performed an extensive examination of every study to verify that they fulfilled the inclusion and exclusion criteria. This study emphasizes on articles that examined the views of people from various backgrounds about the utilization of holograms, AI, VR, and AR in Oman. The selected articles were required to be written in English, published in peer-reviewed journals between January 2020 and October 2025, and employ qualitative, quantitative, or mixed-methods approaches.

To maintain the academic quality and relevance of the review, studies were carefully screened according to these predefined criteria. Research procedures that did not directly contribute to the objectives of the review were excluded, along with verbal presentations, observations, and reports published by Non-Governmental Organizations (NGOs). These criteria helped ensure that the final set of studies was reliable, relevant, and sufficiently rigorous for analysis.

The selection process also made it possible to focus on research that provided clear evidence and meaningful academic contributions. Overall, these decisions helped create a focused and manageable body of literature that could support a balanced understanding of the topic. The preliminary search yielded 86 articles prior to the application of any criteria.

Upon examining the collected studies, we removed 40 duplicates and 12 records deemed ineligible, resulting in 34 articles remaining. A review of the titles and abstracts resulted in the elimination of 20 articles. We subsequently assessed the complete text of the other 11 articles based on study inclusion and exclusion criteria. Figure 1 depicts the process of searching and selecting the earlier studies.

3.2.1. Programming Method

- 1) Country: The studies were collected based on Oman, where the research took place.
- 2) Research Framework: Qualitative research and quantitative research.
- 3) New Technology: utilizing technologies like virtual reality, augmented reality, mixed reality, artificial intelligence, and 3D holograms.
- 4) Study subjects: The targeted individuals were classified into categories of learners, educators, and students. Challenges. Those involved in emerging technology

implementation were assembled into four areas based on findings: Technical, Training & Skills, Financial, and Institutional.

4. Results

4.1. Progression in the Use of Emerging Technology in Oman

Table 1 shows the annual distribution and research topic of emerging technology studies in Omani higher education from 2020 to 2025.

A single study was carried out in 2022, marking the inception of Virtual Reality (VR) adoption research, and it was predominantly concentrated on teachers' intention to use VR in instruction. There were two studies in 2023, a heightened interest in VR owing to, specifically, the COVID-19 pandemic.

The focus in this year shifted to the examination of the application of VR in online and blended learning, a shift from conceptual inquiry to everyday use. Research activity in 2024 expanded with three studies exploring the Metaverse and Augmented Reality (AR) alongside VR. This was succeeded by theoretical models that were diversified and a broader investigation into how learning experiences can be enhanced by a range of emerging technologies.

Table 1. The annual distribution and research topic of emerging technology studies in Omani higher education from 2020 to 2025

Year	No. of Studies	Focus Trend
2020	1	Initial application of 3D-VR learning environments, focusing on students' achievement and motivation.
2021	0	No eligible study identified
2022	2	Early exploration of VR adoption (teacher intention).
2023	2	Increased attention during/post COVID-19; focus on VR in online learning.
2024	3	Expansion into Metaverse and AR; diversified models.
2025	3	Broader perspectives on readiness and perception in education.

Finally, in 2025, there were still three studies, but with a change in focus to institutional readiness, user perception, and learning impact. This shows a direction of research maturing, whereby research does not simply consider adoption, but evaluates the strategic and pedagogical embedding of new technologies in Omani universities. Overall, the table illustrates a steady increase in research activity and in thematic profundity, demonstrating a clear trajectory from initial exploration (2022) to institutional priority across the board (2025).

4.2. Theoretical and Methodological Approaches

Table 2 presents the theoretical frameworks and models utilized in studies examining the adoption of emerging technologies in higher education in Oman between 2020 and 2025. It highlights the frequency of their use and their primary analytical roles, offering an overview of the key conceptual approaches within this research area.

Table 2. Theoretical and methodological approaches

Model	Frequency	Function
Technology Acceptance Model (TAM)	3	Examines perceived usefulness and ease of use.
Unified Theory of Acceptance and Use of Technology (UTAUT)	2	Measures behavioral intention and facilitating conditions.
Technological Pedagogical Content Knowledge (TPACK)	1	Connects technological skill with pedagogical application.
Exploratory / Experimental	4	Descriptive or comparative non-theoretical studies.

Three studies use the Technology Acceptance Model (TAM), which is the most widely used. Its main purpose is to evaluate perceived utility and usability, which are the main factors affecting users' adoption of new technologies like the Metaverse, Augmented Reality, and Virtual Reality. Researchers' interest in the unique cognitive and attitudinal factors that influence technology adoption is reflected in this prevalence. After being used in two studies, the Unified Theory of Acceptance and Use of Technology (UTAUT) is presented.

In order to create a more thorough model for analyzing user adoption behavior, this framework expands on TAM by adding variables like behavioral intention, social influence, and facilitating conditions. Its application shows an attempt to capture the intricate relationship between institutional, social, and individual factors in the adoption of new technologies. This model is called Technological Pedagogical Content Knowledge (TPACK).

4.3. Technology Type Used

Table 3 reveals that the majority of studies in Oman concentrate on Virtual Reality (VR), totaling eight instances, thus making it the most explored technology. The Metaverse is highlighted in two studies, indicating an increasing yet restricted interest, whereas Augmented Reality (AR) is referenced just once. No research has investigated 3D holograms, indicating a need for future studies.

Table 3. Technology type focus

Technology	Frequency
Virtual Reality (VR)	8
Metaverse	2
Augmented Reality (AR)	1
3D Holograms	0

4.4. Sample Distribution

Figure 2 shows that research in the examined studies tends to focus equally on teachers and students, emphasizing either the instructional or learning perspectives, while collaborative participant groups remain underrepresented.

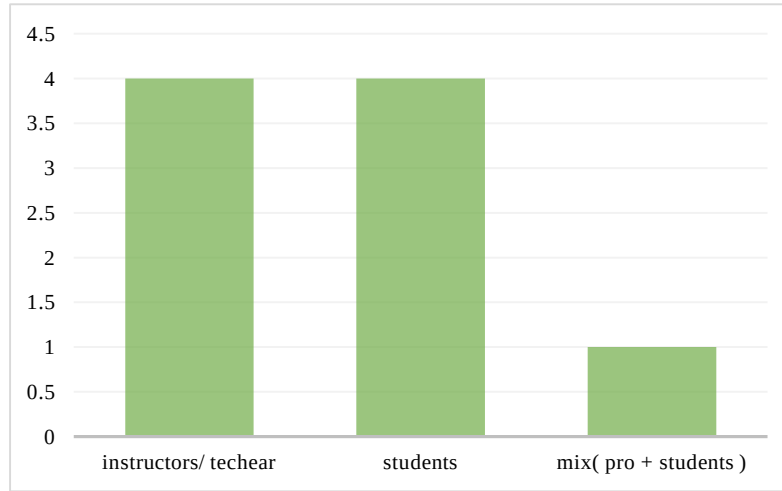


Fig. 2 Sample distribution

4.5. Statistical Tools Used

Figure 3 shows Quantitative dominance indicates that

researchers are prioritizing measurable behavioral and perceptual outcomes of emerging technology adoption

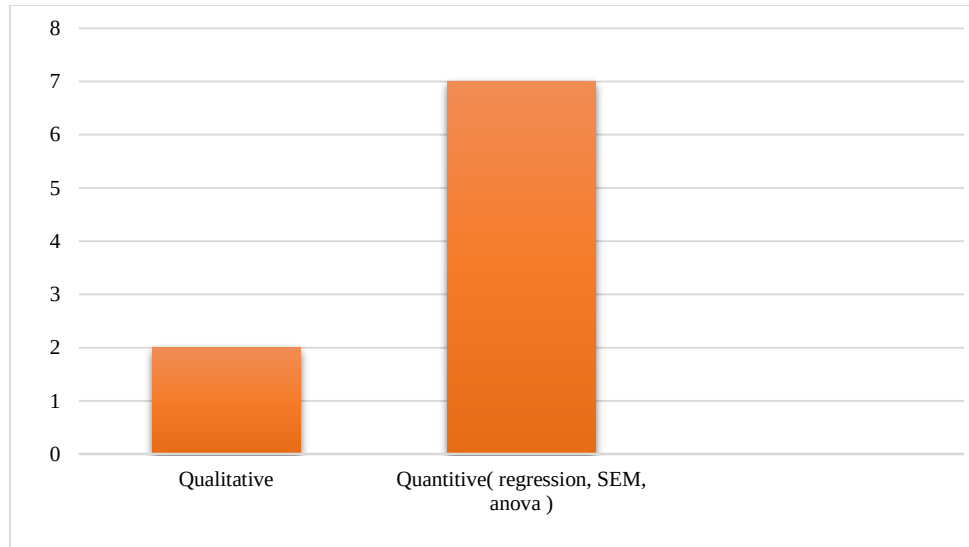


Fig. 3 Statistical tools used

4.6. Institutional Participation

As shown in Figure 4, the bar chart labeled “Studies” indicates the number of studies conducted by different Omani institutions regarding emerging education technologies. It is quite clear that Sultan Qaboos University has the highest number of studies, which is 3, indicating its active role in exploring emerging education technologies. The University of Nizwa and the Ministry of Education each have 2 studies,

indicating their active role in exploring emerging education technologies.

Middle East College, University of Buraimi, Engineering College, and the University of Technology and Applied Sciences each have 1 study, indicating their low level of engagement in exploring emerging education technologies.

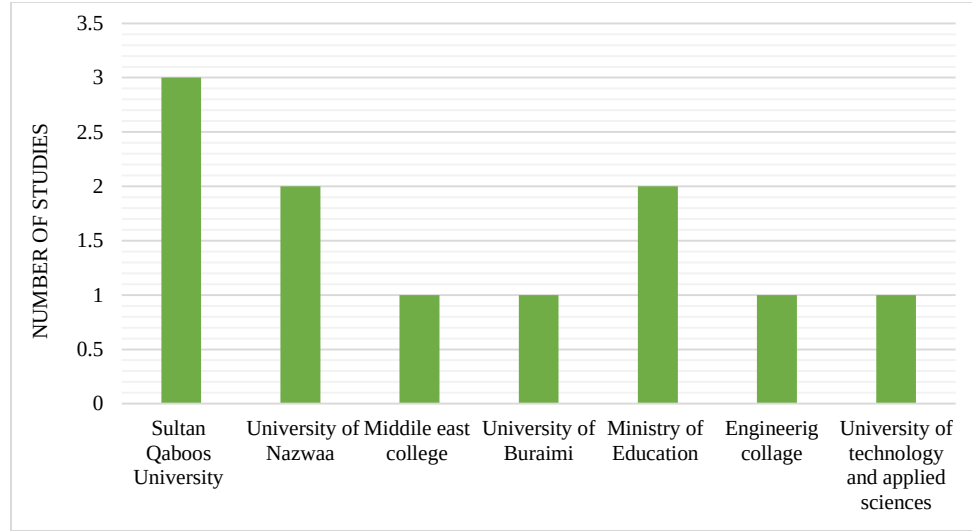


Fig. 4 Institutional participation

4.7. Comparative Analysis of Emerging Technology Adoption

The studies reviewed indicate how the trend of increasingly adopting emerging technologies in Omani higher education has evolved. The most popular technology for engineering, architecture and science education, as reviewed in the study, is Virtual Reality (VR). VR is the dominant immersive technology in today's world. This is because it is relatively mature and offers better accessibility than AR and MR. In contrast, the adoption rate for AR and Metaverse applications is lower, and there are fewer empirical studies. Most studies on Augmented Reality (AR) focused on visualization improvement and interactive learning. In contrast, early studies on Metaverse researched users' readiness and behavioral intention rather than large-scale implementation in education. This distribution indicates that the Omani adoption of emerging technologies takes place incrementally from immersive visualization technologies to intelligent educational ecosystems. As seen in developing countries, adoption priorities are significantly influenced by technological infrastructure, institutional preparedness and implementation costs.

4.8. Comparison with International Literature

The results of this review generally align with international research demonstrating the educational advantages of Virtual Reality, Augmented Reality, and Metaverse technologies. As seen in Saudi Arabia, the UAE, Malaysia, and China, Virtual Reality remains the most researched immersive technology to date, as it is proven to enhance engagement, experiential learning, and spatial cognition.

In contrast to international literature, which has recently seen Artificial Intelligence, Learning Analytics, Digital Twins and Extended Reality as major research themes, research in Omani higher education focuses mainly on the use of Virtual

Reality. The above difference indicates that Omani institutions are still at the nascent stage of digital transformation and have not yet adopted next-generation intelligent educational technologies. In addition, international systematic reviews validate the interdisciplinary incorporation of immersive technologies, Artificial Intelligence and adaptive learning systems. The absence of such integration in the discussed Omani studies presents an important opportunity for future research and educational innovation.

5. Challenges

A classified summary of the typical impediments to the adoption of state-of-the-art technology, such as virtual reality, augmented reality, and the metaverse, in Omani higher education is shown in Table 4. The table demonstrates the intricate nature of impediments to the adoption and integration of technology by categorizing the impediments into technical, training/skills, financial, and institutional impediments. The technical impediments include issues such as expensive software, internet connectivity, and equipment availability. These impediments are basic because they relate to the ease of access and use of state-of-the-art technology in learning institutions. As a result of expensive procurements, higher education institutions lack equipment such as virtual reality devices, thus limiting the use of virtual reality and augmented reality learning technologies.

Table 4. Major challenges

Category	Common Issues
Technical	Limited access to VR/AR equipment, weak internet, software costs
Training & Skills	Lack of pedagogical training, absence of VR content development expertise
Financial	High cost of devices and maintenance
Institutional	Insufficient strategic planning and policy support

The category of training and skills shows that there is a human capacity gap in terms of educational technology. Most teachers are not knowledgeable in terms of technology and its use in lesson planning and executing virtual and augmented reality lessons. Moreover, there is limited content development in virtual and augmented reality technology due to limited expertise in creating content that is both specific and relevant in nature. In terms of the financial category, there is a limitation in terms of costs associated with virtual and augmented reality technology. Most of these emerging technologies are constantly being updated and are expensive in nature. They also require constant maintenance and technical support, making it difficult for most institutions and schools to adopt these technologies due to limited budgets in most schools. The institutional factor highlights a lack of supporting policies and strategies in integrating technology. There is a lack of a plan or a framework in most institutions to guide the use of immersive technology in learning. Unlike a systemic and integrated approach, there is a fragmented one based on instructor-level initiatives. Curriculum development, training, and budgeting all face challenges due to a lack of institutional support. As shown in the table, technical and financial issues underpin skill and policy weaknesses, suggesting a systemic relationship among barriers. To leverage technology to maximize its benefits in enhancing teaching and learning in Omani higher education, addressing the barriers to its integration will require a systemic response, including developing strategies in institutions, staff development, infrastructure development, and ensuring long-term funding.

5.1. Key Findings and Recommendations

Common findings across studies include:

- Participants exhibit positive attitudes and a high interest toward immersive technologies.
- Adoption is constrained by limited resources, training deficits, and institutional policies.
- Emerging technologies (especially VR and AR) can enhance engagement, motivation, and understanding when effectively integrated into teaching.

Collective recommendations emphasize:

- 1) Enhancing digital infrastructure in universities and schools.
- 2) Providing continuous teacher training on immersive pedagogy.
- 3) Developing localized VR/AR educational content.
- 4) Encouraging collaborative research among Omani institutions.
- 5) Exploring 3D holographic and mixed-reality technologies in future projects.

6. Discussion

6.1. Overview of Emerging Technology Trends (2020-2025)

The examined studies reveal a progressive trend in the

adoption and exploration of novel technologies in Omani higher education between 2020 and 2025. Trend analysis indicates a clear evolution from earlier explorations of Virtual Reality (VR) applications in 2022 towards broader explorations involving Augmented Reality (AR) and the Metaverse in 2024 and 2025. Studies increased from one study in 2020 to two in 2022, two in 2023, three in 2024, and three in 2025, suggesting enhancing institutional and scholarly interest in immersive learning environments. This increasing trend is simultaneous with post-COVID-19 transitions into digital and hybrid learning spaces, where novel technology acted as essential enablers of enhanced interactivity and engagement of learners. By 2025, the interest in research had progressed beyond adoption to examining readiness for study, perception, and pedagogical integration among instructors as well as students. This is proof of a phase of maturation in implementation where the debate has progressed from feasibility to sustainability and policy backing at an institutional.

6.2. Theoretical Models and Analytical Frameworks

The use of theoretical models in all of the studies that have been reviewed shows a mixed yet complementary approach to understanding technology acceptance in education. The Technology Acceptance Model (TAM) is the most widely used technology acceptance model, with three studies utilizing this theory to investigate users' perception of use, ease of use, and overall usefulness of technology in both VR and AR settings [9]. Another widely used technology acceptance theory is UTAUT, with two studies utilizing this theory to investigate technology acceptance in Omani education. UTAUT concentrated on behavioral intention, social influence, and facilitating conditions in Omani education settings [10].

One of the studies utilized the Technological Pedagogical Content Knowledge (TPACK) theory to identify where technological knowledge overlaps with pedagogical and content knowledge, more particularly in the Metaverse environment. Apart from widely used technology acceptance models, some of the studies utilized exploratory and experimental approaches, where researchers were able to investigate the impact of immersive technologies with a degree of theory limitation. This is a clear indication of a more advanced use of technology in Omani education, with a move towards widely used technology acceptance models like TAM and UTAUT, in line with international best practices in evaluating technology in learning settings.

6.3. Challenges in Adopting Emerging Technologies

One common thread that ran through all the studies reviewed here has been the identification of the challenges that impede the development and acceptance of VR, AR, and Metaverse-based applications and solutions. These challenges have been classified into four main areas:

- Technical challenges refer to issues such as access to equipment, internet connectivity, and software compatibility. These have been identified as barriers by several scholars, including [7, 11]
- Training and skills challenges refer to issues such as a lack of pedagogical training and the ability to effectively utilize immersive content. This has been identified by [9, 12].
- Financial challenges refer to issues such as the cost of equipment and software. These have been identified as barriers by [9, 13].
- Institutional challenges refer to issues such as the need for a national policy and long-term support. This has been identified by content [8]. Through these issues, Omani higher education is able to utilize the upcoming technologies to make the learning process more engaging, efficient, and equitable.

These challenges are multi-dimensional and have shown that while the Omani universities are technologically ready for VR and AR applications, they are still impeded by other challenges.

6.4. Institutional and Pedagogical Implications

The results show that the successful integration of new technology in higher education in Oman calls for a strategic alignment of organizations in terms of upgrading the infrastructure, policy support, and human resource capabilities. Organizations that are focused on developing professional skills show higher teacher participation and creativity [14]. Conversely, individuals who are not supported show disjointed execution and limited educational achievements. From the point of view of education, the reviewed literature shows that the research proves that immersive technology shows higher student engagement, interest, and spatial understanding, especially in fields like architecture and interior design. However, to achieve this, teachers' readiness, curriculum changes, and the development of specific content are necessary to suit the Omani education system. Omani higher education research is mostly focused on Virtual Reality types of research compared to international systematic reviews, where Artificial Intelligence dominates. This difference shows the maturity of knowledge adoption using immersive technology in Oman and shows that this could be appropriate for expanding use of AI-supported learning environments.

7. Future Directions and Recommendations

Based on the reviewed evidence, several recommendations emerge for advancing emerging technology adoption in Omani higher education:

1. **Infrastructure Enhancement:** Strengthen internet connectivity and invest in affordable VR/AR equipment accessible to both students and instructors.

2. **Capacity Building:** Establish continuous professional development programs focused on pedagogical integration of immersive technologies.
3. **Policy Development:** Implement institutional frameworks and national strategies to promote sustainable and inclusive technology use.
4. **Content Localization:** Encourage the creation of Arabic-language VR/AR educational content aligned with Omani curricula.
5. **Collaborative Research:** Promote cross-institutional research and partnerships with international universities to foster innovation and share best practices.

8. Conclusion

It has been established in the discussion that the sector of higher education in Oman is moving towards technological experimentation to systematic implementation of immersive learning tools.

As the advances are clear in the increasing interest in research and the development of models, the existing challenges, especially technical, financial, and institutional ones, still have to be addressed.

The success in the future will be based on the extensive support of the policy, training of educators, and the local development of technology.

8.1. Recommendations

8.1.1. Infrastructure and Accessibility

To guarantee equal opportunities, universities need to focus on expanding their digital facilities, such as high-speed internet, cloud-based learning platforms, and dedicated VR/AR laboratories. Collaborating with technological suppliers can also assist in minimizing expenses and enhance scalability.

8.1.2. Professional Growth and Pedagogical Wholeness

The institutions need to initiate Continuous Professional Development (CPD) programs that focus on improving the technological and pedagogical skills of the educators. Long-term capacity of instruction is possible to be developed through workshops and certification programs in immersive instructional design [6, 9].

8.1.3. Policy and Strategic Alignment

A national approach towards technology adoption in the institutions of higher learning should be drawn. This plan must also have clear policies regarding digital pedagogy, quality assurance, funding models, and ethical issues regarding data privacy and virtual space [8].

8.1.4. Financial Sustainability

Since the costs of immersive technologies to be introduced initially and maintained are high, it is essential to develop sustainable funding models. VR/AR initiatives can be

piloted and extended through institutions with the assistance of Public-Private Partnerships (PPPs) and competitive grants without relying on short-term projects [13].

8.1.5. Cultural Adaptation and Content Localization

To be culturally relevant and achieve pedagogical efficacy, it is necessary to develop localized Arabic-language content. University-ministry-local developer cooperation can be used to encourage content that is in line with Omani curricula and cultural values [12].

8.1.6. Research and Innovation Networks

Omani universities need to develop joint research centers

where they specialize in the newer technological advancements in the field of education in order to develop a strong research ecosystem. Cooperation with other countries will help to exchange more knowledge and innovate [15].

Ethical approval

Not applicable

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Appendix: A comparative analysis of previous studies**Table 5. Studies**

S.No	STUDY	Purpose	Factors	Challenges	Model	Statistical Tool	Institution	Technology Type	Sample Size	Type of Sample	Key Findings / Recommendations
1	Saleh et al. (2025)	Assess readiness and perception of architectural students toward adopting VR.	Performance expectancy, effort expectancy, social influence, facilitating conditions.	Limited infrastructure and cost constraints.	UTAUT	Structural Equation Modeling (SEM)	Sultan Qaboos University	VR	61	Students + Professionals	Positive attitude toward VR adoption; recommends institutional investment and VR-based curriculum integration
2	Al-Maroofo (2024)	Examine the influence of TPACK on educators' readiness to adopt Metaverse-based learning.	Technological knowledge, pedagogical integration, perceived usefulness.	Lack of training and institutional policies.	TPACK	SEM-AMOS	University of Nizwa	Metaverse	342	Instructors	TPACK strongly predicts Metaverse adoption; recommends continuous professional development.
3	Gupta & Bhaskar (2023)	Identify determinants of teachers' intentions to use VR.	Perceived ease of use, attitude, facilitating conditions.	Lack of technical support and awareness.	TAM	Regression Analysis	Collaboration (India-Oman)	VR	508	Instructors	Positive behavioral intention linked to perceived usefulness; recommends technical support programs.
4	Al Breiki et al. (2022)	Explore behavioral intention of science teachers toward VR use.	Effort expectancy, performance expectancy, social influence.	Lack of training and access to VR labs.	UTAUT	Descriptive & Regression	Ministry of Education (Oman)	VR	171	Instructors	Teachers show readiness but need institutional and technical support for implementation.
5	Al Buraiki et al. (2025)	Evaluate teachers' readiness to use AR tools in science teaching.	Technological readiness, motivation, institutional support.	Lack of technical infrastructure.	Exploratory	Descriptive Statistics	University of Nizwa	AR	10	Instructors	Found moderate readiness; recommends improved infrastructure and localized AR content.
6	Al Farsi (2023)	Analyze factors influencing VR adoption during remote learning.	Technological accessibility, cost, perceived benefit.	Device availability and internet speed.	TAM	Regression & Correlation	Middle East College (Muscat)	VR	32	Students	VR improved engagement and motivation; recommends hybrid models integrating VR.
7	Al-kfairy (2024)	Study determinants of willingness	Enjoyment, self-efficacy, performance	High cost, lack of standardization.	TAM	SEM-PLS	University of Technology and Applied	Metaverse	35	studies reviewed	Students show curiosity but low adoption confidence;

		toward Metaverse adoption.	expectancy.				Sciences				suggests awareness and training programs.
8	Al Musawi et al. (2025)	Explore teachers' perceptions toward VR integration in language teaching.	Attitude, pedagogical value, perceived ease of use.	Lack of VR content and limited exposure.	Exploratory	Descriptive & Thematic	Sultan Qaboos University	VR	20	Instructors	Positive perception; recommends development of VR-based EFL materials and training.
9	Kandil & Moussa (2024)	Compare project outcomes using VR vs. traditional assessment methods.	Engagement, visualization capability, design quality.	Equipment cost and learning curve.	Experimental	t-test, ANOVA	University of Buraimi	VR	40	Students	VR enhances understanding and creativity; recommends curriculum inclusion of immersive tools.
10	Al Amri, A. Y., Osman, M. E., & Al Musawi, A. S. (2020)	To examine the effectiveness of a 3D Virtual Reality Learning Environment (3D-VRLE) on Omani 8th-grade students' achievement and motivation towards physics learning	Student engagement, learning motivation, 3D visualization.	Limited technical infrastructure and teacher familiarity with VR.	Experimental design (pre/post).	ANOVA, t-test.	Sultan Qaboos University.	VR	65	Students	VR significantly enhanced motivation and achievement; recommended integration of 3D-VRLE in science curricula.
11	Yousif (2022)	To design a VR/AR environment for engineering training.	Visualization, interactivity, skill application.	High cost and hardware constraints.	Experimental training model.	Pre/post comparison.	Engineering College, Oman.	VR/AR simulation.	180	Engineering students.	VR/AR improved conceptual understanding and technical competence.