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# THE EDU-METaverse: A STUDY OF POTENTIAL, CHALLENGES, AND FACULTY PERCEPTIONS IN GCC HIGHER EDUCATION

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## ABSTRACT

*Collaborative learning experiences. This study examines its integration into higher education, focusing on the Gulf Cooperation Council (GCC) region. We review current Metaverse tools and challenges and complement this with an original survey of 169 GCC faculty members. Findings reveal strong faculty confidence in the Metaverse's potential to enhance student engagement and collaboration, while also highlighting significant barriers, including high costs, limited infrastructure, and the need for professional development. By combining a systematic literature review with empirical regional data, this study provides a comprehensive assessment of the educational Metaverse and offers actionable insights for educators and policymakers, including gradual integration strategies, faculty training, infrastructure investment, and the development of standards and collaborative initiatives to maximize its educational potential.*

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**KEYWORDS:** Education, Metaverse, Virtual reality, Augmented reality, AI, Immersive technology.

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## 1. INTRODUCTION

The term metaverse originated in Neal Stephenson's 1992 science fiction novel *Snow Crash* (Shu and Gu 2023) and gained renewed public attention with Mark Zuckerberg's rebranding of Facebook to Meta in 2021 (De Felice et al 2023). It is broadly defined as a post-reality universe, a perpetual and persistent multi-user environment that merges physical reality with digital virtuality (Zhou 2022). In education, the Edu-Metaverse is understood as a virtual reality or digitized space that parallels the real world, enabling embodied and multimodal interaction, and immersive teaching scenarios (Shu and Gu 2023).

The metaverse is emerging as a revolutionary force in education providing learning opportunities that can boost both student engagement and accessibility. By harnessing advanced technologies like virtual reality (VR), augmented reality (AR) and mixed reality (MR), this innovative platform is creating promising, dynamic and engaging educational environments. Metaverse refers to a virtual world where individuals can interact with each other and with other digital objects in real time (Rahman et al 2023). Metaverse-based learning provides immersive and engaging educational experiences, enhancing both student participation and performance. It facilitates virtual field trips, interactive simulations, and collaborative activities, improving educational accessibility and enriching learning opportunities (Belmonte et al 2024) (Akbar et al 2024) (de Bem Machado et al 2024) (Rane et al 2024).

Metaverse technologies have the potential to revolutionize the way we are teaching and learning nowadays. Several studies investigated the impact of using metaverse technologies on education such as VR, AR, MR and AI. For example, the effectiveness of digital teaching resources in the teaching-learning process is tested (de la Plata et al 2023). The results shown in the paper proved the effectiveness of the methods used. The interest and motivation of the students have been improved by immersing them in their own training. An empirical study presented in (Alkhabra et al 2023) showed that using VR enhanced the critical thinking and learning retention. Another empirical study investigated understanding the role of digital immersive technology in educating the students of English language (Tang 2024).

The rapid evolution of metaverse technologies has increasingly captured the attention of higher education administrators and instructors. Contemporary research highlights several established metaverse tools that exhibit substantial

promise for enhancing educational outcomes (Sánchez-López et al 2022).

The results showed that digital immersive technology played a crucial role in achieving sustainable education, both directly and indirectly. These findings suggest that teachers and policymakers should support and promote the use of digital technology in teaching English, helping students develop critical skills and strategies for self-directed learning.

The metaverse has the potential to transform various aspects of current educational practices, such as providing immersive and interactive learning experiences, enhancing visualization of complex concepts, reducing learning costs and risks, and enabling personalized learning approaches. Several companies started producing Meta-verse products for learning such as Roblox, Strivr, Space etc. Roblox. For example,

Roblox develops educational games. Strivr provides VR training solutions to businesses, while Space produces various interactive 3D models for learning. Additionally, several universities, including Stanford University, Case Western Reserve University, and the Hong Kong University of Science and Technology, have integrated metaverse technologies into their campuses (Lin et al 2022a).

As with any new technology, the use of metaverse technologies comes with its own set of obstacles and challenges. The challenges of applying metaverse technologies in education are due to factors related to humans such as security, privacy, social, and ethical issues. On the other hand, infrastructure limitations and device challenges are associated with the metaverse technologies. One more issue, the effectiveness of using metaverse in education is still requires further investigation (Kaddoura and Al Husseiny 2023). In addition to the previously mentioned changes, another study highlighted that incorporating Metaverse technologies in education may raise concerns related to health. For example, the extensive use of the metaverse can lead to various health issues. Physical problems may include head and neck fatigue, eye strain, headaches, and nausea. Psychologically, users, especially young learners, may face addiction, social isolation, and antisocial behavior. There is also a risk of cyber-bullying and harassment in virtual environments, which can significantly impact mental health. Governance is another critical issue, where the establishment of clear guidelines and regulations is essential to ensure a secure and respectful learning environment (Said 2023).

This study explores the latest literature on the use

of the metaverse in education,

discussing both the promising outcomes highlighted and the challenges posed by its implementation. To make this article self-contained, a brief overview of the various metaverse tools and technologies is also discussed.

The remainder of this article is organized as follows: Section 2 reviews the most recent related work in the domain of metaverse. Section 3 introduces and discusses metaverse tools, technologies and challenges. Section 4 examines the status of metaverse awareness and adoption in GCC higher education system. While Section 5 concludes the paper and highlights directions for future work.

## 2. RELATED WORK

Given the rapidly evolving nature of the metaverse domain, this section reviews selected studies from the most recent literature. Since the concept of the metaverse gained global popularity in 2021, often referred to as the 'first year of the metaverse' (Wang 2022), most of the studies discussed here were published in 2022 or later. The primary focus is to examine the outcomes of applying metaverse technologies in education and to identify the key challenges associated with their implementation.

Based on recent articles on the use of metaverse technologies and tools in education, several benefits have been observed in relation to student learning outcomes, engagement, and skill development (Shu and Gu 2023).

An empirical study involving 60 college English students at Zhejiang Open University found that the experimental group using a smart education model in the

Edu-Metaverse achieved higher scores in oral English, vocabulary and grammar, reading comprehension, English-to-Chinese translation, and writing than the control group receiving traditional instruction (Shu and Gu 2023). The most significant progress was observed in oral English and writing, which was attributed to the use of smart tools like an oral training platform and an AI-powered writing platform.

In nursing education, metaverse simulations improved students' ability to administer medication safely (Roy et al 2023). In science and history, platforms like Minecraft increased academic learning (Lee and Hwang 2022). Similarly, an AR-based Metaverse application in mathematics was shown to enhance students' learning outcome (Tlili Ahmed 2022).

The use of VR technologies in the classroom has

been found to improve both short- and long-term knowledge retention and experiences with creating VR content and linking it to a metaverse platform were shown to improve pre-service teachers' technological readiness and raise their awareness of the need for tailor-made instructional materials (Lee and Hwang 2022). On the other hand, metaverse platforms provide immersive, interactive, and enjoyable learning experiences that increase student engagement and motivation (L'opez-Belmonte et al 2023). Students find digital textbooks with VR content more engaging because they incorporate multimedia sources like videos and animations (Lee and Hwang 2022).

Students have reported high satisfaction with metaverse-based learning. In one study, 92% of students felt their involvement and attention had improved, especially in speaking, writing, and reading skills (Shu and Gu 2023). Another study found that a virtual teaching environment led to satisfactory experiences and an adequate level of acceptance among students (L'opez-Belmonte et al 2023).

The "gamifying" of learning is a key benefit, making education feel like a video game and inspiring students to perform better. Students often find learning in the metaverse to be fun and interesting, which sustains their engagement (Kaddoura and Al Husseiny 2023).

The metaverse enables learners to engage in complex activities like problem-solving and inquiry-based learning, which helps develop high-order thinking skills such as analysis, evaluation, and creation (Zhang et al 2022). A study on pre-service teachers found that creating VR content helped develop creativity, critical thinking, and collaboration skills (Lee and Hwang 2022).

Metaverse environments promote collaboration and communication by allowing students to work together on projects, share ideas, and interact in real-time regardless of physical location (Shu and Gu 2023).

A survey of 336 elementary school students found that 97.9% had experience with the metaverse, and 95.5% considered it closely related to their lives. Students generally perceive these tools as easy to use (Suh and Ahn 2022).

In a study creating a virtual neurosurgery anatomy lab, participants strongly agreed that the system should be part of residency training and that virtual cadaver courses on the platform could be effective for education (Gonzalez-Romo et al 2023). Finally, using metaverse technologies and shown showed positive effect and enhanced academic

performance and learning outcomes, increased student engagement, improved motivation, and satisfaction, aided in development of key skills, improved student and teacher perceptions.

### 3. METAVERSE TOOLS, TECHNOLOGIES AND CHALLENGES

This section addresses both metaverse technologies and the associated challenges. While it does not offer a comprehensive review of all available metaverse tools and platforms, it provides sufficient information for most educators to explore the options and gain a solid understanding of the key technologies and challenges involved.

The technologies behind the metaverse focus on immersing users in new environments where physical and temporal limitations can be overcome. These technologies include Virtual Reality (VR), augmented reality (AR), mixed reality (MR), brain-computer interfaces (BCIs), game engines, 3D modeling, and real-time rendering (Shi et al 2024). For these technologies to function effectively, additional resources are required, such as reliable connectivity, sufficient budgets, user training, and consideration of legal and ethical issues (Maria 2023). On top of these tools and technologies is the artificial intelligence (AI), which can further enrich and enhance the teaching and learning process. Table 1 (Shi et al 2024) summarizes most of the metaverse technologies.

One of the most prominent tools is VR simulation platforms, which include products such as the Oculus Quest and HTC Vive. These platforms enable immersive learning experiences by simulating realistic scenarios that promote active student

engagement (Parong and Mayer 2018).

Tools like Microsoft HoloLens offer AR/MR experiences that seamlessly integrate virtual content into the physical environment, see Figure 1. Educational institutions can leverage AR to overlay complex scientific models within classroom settings (Wyss et al 2021).

Furthermore, platforms such as ENGAGE's Spatial have been developed specifically to facilitate remote learning and virtual classroom experiences (Perinpasingam et al 2023). ENGAGE, for instance, is designed to host large-scale immersive virtual environments where instructors can conduct lectures, virtual libraries, and interactive programs, see Figure 2. Even though the majority of research shows that using virtual reality (VR) in higher education improves learning results as well as student engagement and satisfaction, it didn't seem like a good alternative to conventional teaching techniques (Santilli et al 2025). The cost analysis for platforms like ENGAGE is highly favorable in the long term, as subscription-based models allow institutions to scale usage while avoiding significant capital expenditures. Minimum software requirements include modern web browsers with WebGL support, and in some cases, optional VR headset compatibility for enhanced immersion.

Spatial, another metaverse tool, emphasizes ease of integration with existing educational software and platforms, see Figure 3. As a cross-platform solution, Spatial supports desktop, mobile, and VR interfaces, making it suitable for institutions aiming to provide flexible learning environments without compromising the quality of the experience (De Marco 2024). Table 2 shows a set of tools used in education.

*Table 1: Technologies Of Metaverse.*

Technology	Description	Used for
VR	Depict a virtual environment generated by computers and depends on external devices such as helmets and glasses	Immersive Learning, safe simulation, increase Engagement and Motivation
AR	A technology that seamlessly integrates virtual content into the real world environment. It utilizes techniques such as multimedia, 3D modeling, and real-time tracking. Sensors like accelerometers, GPS, and infrared are significant.	Improve users' immersion
MR	Hybrid of AR and VR, needs real-time information about real objects to achieve digital modeling and co-existence of real and virtual objects	Improve users' immersion
BCIs	Enables direct communication between the brain and external devices, translating brain signals into commands.	Enhances student engagement, personalized learning, etc.

	Enhances engagement and personalized learning.	
Game engines	Predefined code for games that sets interactions between virtual and real environments	Helps users create immersive experiences
3D modeling	Constructing a mathematical model of objects. Holographic projection is one kind of 3D modeling	Enhances visualization and understanding
Real-time rendering	Studies how to create and analyze real-time 3D images, rendering constantly changing environments	Enables immersive user experiences in metaverse
AI	Core technology for intelligent digital tools and systems	Enables intelligent tutors and personalized learning guidance

The challenges associated with the use of metaverse technologies and tools in education are linked to a variety of factors, including technological limitations, concerns about physical and psychological health, risks of addiction and social disconnection, as well as issues of privacy and security. Table 3 summarizes these challenges.

Even though Table 3 shows a long list of challenges that face using metaverse tools and technologies in education, research increasingly indicates that despite significant challenges such as concerns over privacy and security, health and

psychological effects, and the risk of addiction the metaverse offers great potential to revolutionize education. Systematic reviews highlight its capacity to create immersive, collaborative, and learner-focused environments that boost engagement, critical thinking, and personalized learning experiences. Nonetheless, overcoming infrastructural limitations, ensuring equitable access, and addressing ethical issues are crucial to fully realizing this potential (Camilleri 2024) (Ghoulam and Bouikhalene 2024).

*Table 2: Tools Of Metaverse.*

Metaverse	Techno-logy	Application/Use in Education	Impact on Education	Ref
Edu-Metaverse		Provides a new educational environment; integration of information technology in teaching-learning practices; twin of the actual educational world; supports smart education.	Initiates great and unprecedented change; reshapes the education ecosystem; promotes the transformation of smart education; overcomes shortcomings of traditional education; forms a new system of unified and coordinated smart education ecosystem; improves educational quality and efficiency; allows students to achieve deep learning; develops capacity for high-order thinking; helps students become intelligent individuals in an online learning space; fosters wisdom-oriented talents; provides a new experience in social communication space; offers creation and sharing freedoms; high immersion and virtualization; provides intelligent analysis, explanations, and conclusions; extends educational space; promotes deep interactions between learners; balances ecological niches of students, teachers, society, and schools; offers a learning-oriented society where "everyone can learn things at anytime, anywhere."	(Shu and Gu 2023)

HTC Vive	Has potential use in academic and learning environments considering cost, ease of setup, and support for academic and research use.	Presents a significant impact on education by democratizing access to motion capture technology, making it more feasible for academic and learning environments.	(Kulozik and Jar-rass'e 2024)
Microsoft HoloLens 2	Applied in education primarily for delivering clinical tutorials to medical students through Mixed Reality (MR).	Enhances clinical teaching in medical settings via MR capabilities; addresses challenges like increasing student numbers, limited access to patients and tutors.	(Connolly et al 2024)
ENGAGE	Virtual Reality learning designed to enrich language learning experiences in English as a Foreign Language (EFL) classrooms.	Strong evidence that integrating the Engage VR learning application has a positive effect on intermediate EFL learners.	(Saeedizadeh and Khod-abandeh 2024)
Spatial	Avatars can be created on SPATIAL.io that enable users to interact with others in virtual spaces. A main objective of SPATIAL.io is enhancing education.	Provides evidence for using Game-Based Learning (GBL) in metaverse spaces on SPATIAL.io; contributes valuable insights into online and 3D virtual learning; guides improving effectiveness of online education.	(Vate-U-Lan and Cahill 2024)

**Table 3: Challenges Of Using Metaverse In Education.**

Challenge	Description	Ref
High Cost of Equipment and Infrastructure	Access to the metaverse requires expensive hardware such as well-designed, comfortable VR/AR headsets, which is a significant barrier for many students and educational institutions. This cost factor can widen the existing digital divide, excluding those from low-income backgrounds.	(Said 2023)
Network and Computing Power Demand	The metaverse requires immense network capacity for high-resolution rendering and low latency for real-time interactions, which may exceed the capabilities of current 5G technology. It also demands substantial computing power for simulation and data processing, putting a strain on servers and client devices.	(Kaddoura and Al Hus-seiny 2023)
Physical Discomfort and Safety	Users of wearable devices often experience physical discomfort such as cybersickness, motion sickness, dizziness, blurred vision, nausea, and head/neck fatigue, which can limit usage duration and pose safety risks. Some devices are incompatible with eyeglasses or certain hairstyles.	(Kaddoura and Al Hus-seiny 2023)
Lack of Standards and Interoperability	The underlying technologies are immature, and there is a lack of uniform standards across platforms and devices. This makes it difficult to transfer content between Metaverse environments and integrate various complex technologies like AI, digital twins, and blockchain.	(Shi et al 2024)

Extensive Data Collection and Privacy Risks	The metaverse enables the collection of detailed and sensitive user data, including biometric information, facial images, physical states, and behavioral patterns. This raises concerns about privacy violations, surveillance, data leaks, and "biometric psychography."	(Lin et al 2022b)
Cybersecurity Vulnerabilities	The complexity of the metaverse amplifies potential cybersecurity weaknesses. Anonymity can increase criminal activities such as fraud, cyber-bullying, and harassment. Platforms are also susceptible to attacks on devices, user data, and digital twin models.	(Zhang et al 2022)
Intellectual Property Concerns	Managing and protecting intellectual property rights of educational content created by teachers and students is challenging. The decentralized and user-generated nature of content creates high risks of plagiarism and ambiguity over ownership.	(Kaddoura and Al Hus-seiny 2023)
Ethical and Moral Dilemmas	High freedom allows spread of false information and raises concerns about cross-cultural, racial, and religious conflicts. There are risks of unauthorized experiments on virtual humans and exposure to extreme content. Balancing corporate profits with user rights and ethics is a key challenge.	(Zhang et al 2022)
Addiction and Social Disconnection	The immersive nature of the metaverse creates a high risk of addiction, leading to physical, social, and mental issues, social isolation, and neglect of real-world relationships.	(Said 2023)
Cognitive Overload	Multisensory stimuli and high information density increase cognitive workload, potentially amplifying phenomena like "Zoom fatigue."	(Said 2023)
Teacher Readiness and Training	Many educators lack knowledge and skills to design and implement learning in complex virtual environments. Professional development is needed to prepare teachers as virtual environment builders and data analysts.	(Go'c'en 2022)
Content and Curriculum Design	Gap between theoretical research and practical applications makes designing meaningful educational scenarios difficult. Interdisciplinary collaboration between educators and tech companies is often lacking.	(Shi et al 2024)
Cultural Bias	The predominant culture in some metaverse platforms is defined by early Euro-American users, potentially marginalizing later users from different cultural backgrounds.	(Sa'nchez-Lo'pez et al 2022)



Fig. 1: Microsoft HoloLens



Fig. 2: ENGAGE



Fig. 3: Special

#### 4. STATUS OF METAVERSE AWARENESS AND ADOPTION IN GCC HIGHER EDUCATION

A survey was conducted across GCC countries to examine the awareness and adoption of Metaverse technology in higher education institutions and to assess faculty perceptions of its use. A total of 169 responses were collected from universities across the region. This section presents an analysis of the survey responses. Among the respondents, 134 reported six or more years of teaching experience in higher education, while 35 had between zero and five years. Participants represented a range of academic disciplines, including science, engineering, information technology, business, and related fields.

Q1: How familiar are you with the concept of metaverse?

Of the total participants, 43 (25%) reported being very familiar with the topic, 95 (56%) were somewhat familiar, and 31 (18%) were not familiar. This indicates that 75% of the respondents were either familiar or somewhat familiar with the topic.

Q2: Have you ever used or interacted with the metaverse-related technologies (e.g., virtual reality, augmented reality, mixed reality, immersive 3D environments) in any way?

A total of 96 participants (57%) reported that they had used or interacted with metaverse-related technologies. The remaining 73 participants (43%) indicated that they had not been exposed

to such technologies.

Q3: How would you rate your understanding of how metaverse technologies can be applied in education?

Participants' knowledge of metaverse applications in education was distributed as follows: Excellent (29; 17%), Good (62; 37%), Fair (47; 28%), and Poor (31; 18%). This shows that nearly half of the respondents (over 46%) have only a fair or poor understanding of how Metaverse technologies can be utilized in education, potentially posing a significant barrier to adoption of Metaverse technologies in academic environments.

Q4: Have you used digital or immersive technologies (e.g., VR, AR, MR or 3D simulations) in your teaching?

The participants' responses were:

- Yes, frequently (10; 7%)
- Yes, occasionally (54; 32%)
- No, but I am interested (93; 55%)
- No, but I am not interested (12; 6%)

The responses to Q4 reveal a gap between interest and actual use of digital or immersive technologies in teaching. While only a small fraction of participants (7%) use such technologies frequently and about one-third (32%) use them occasionally, a majority (61%) have not yet incorporated them into their teaching. However, most of these non-users (55%) are interested in exploring these tools, indicating strong potential for adoption if adequate support, training, and resources are provided. This suggests that lack of familiarity or access, rather than lack of interest, may be a key barrier to integrating VR, AR, MR, or 3D simulations into educational practice.

Q5: How comfortable do you feel incorporating new technologies such as metaverse into your teaching methods?

The participants' responses were:

- Very comfortable (47; 28%)
- Somewhat comfortable (64; 38%)
- Neutral 48(28%)
- Somewhat uncomfortable (9; 5%)
- Very uncomfortable (1< 1%)

The responses to Q5 indicate that most participants feel comfortable incorporating new technologies such as the metaverse technologies into their teaching. Specifically, 28% reported feeling very comfortable and 38% somewhat comfortable, totaling 66% of respondents. Meanwhile, 28% were neutral, and only a small fraction felt somewhat uncomfortable (5%) or very uncomfortable (<1%). This suggests a generally positive attitude toward adopting emerging educational technologies, although portion remains undecided, highlighting

the potential benefit of guidance, training, or demonstrations to increase confidence further.

Q6: Do you think that metaverse technologies can enhance student engagement and learning outcomes in education?

The participants' responses were:

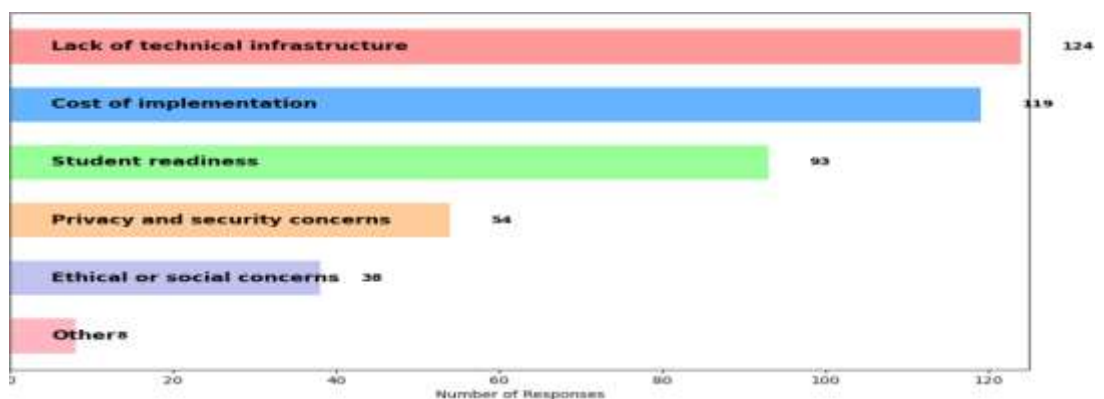
- Strongly agree (49; 29%)
- Agree (87; 51%)
- Neutral (27; 16%)
- Disagree (5; 3%)
- Strongly disagree (1<1%)

The responses to Q6 indicate a strong positive perception of metaverse technologies among participants. A majority (80%) either strongly agree (29%) or agree (51%) that Metaverse technologies can enhance student engagement and learning outcomes. Only a small portion were neutral (16%) or disagreed (3%), and less than 1% strongly disagreed. This suggests that most participants recognize the potential educational benefits of these technologies, which could support their adoption if adequate resources and training are provided.

Q7: In your opinion, the challenges in using metaverse technologies in education is/are? (please, select all that apply).

The results for this question are presented in Figure 4. They indicate that the most significant challenge is the lack of technical infrastructure, followed by the cost of implementation and student readiness. In contrast, participants perceived privacy and security concerns, as well as ethical or social concerns, as notably less critical at this stage.

this stage.

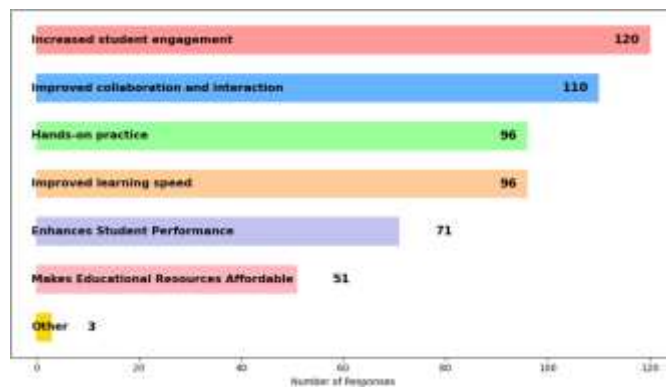


**Fig. 4: Challenges In Using Metaverse Technologies.**

Q8: What benefits do you think Metaverse technologies could bring to education? (please, select all that apply).

The results for this question are presented in Figure 5. The survey findings indicate that the most recognized benefits of metaverse technologies in

education relate to enhancing student engagement and interaction. The highest-rated advantages were "Increased student engagement" (120 responses) and "Improved collaboration and interaction" (110 responses), reflecting a strong belief that immersive tools are effective in attracting learners' attention and supporting social learning. On the other hand, the high ratings for "Hands-on practice" and "Improved learning speed" (both with 96 responses) show that participants value the metaverse for enhancing experiential and efficient learning. In contrast, fewer respondents agreed that these technologies directly "Enhance Student Performance" (71 responses) or "Make Educational Resources Affordable" (51 responses). This suggests that although engagement-related benefits are well recognized, there is less certainty regarding their direct influence on learning outcomes and cost, indicating a need for more improvement in these areas to encourage broader implementation.



*Fig. 5 The benefits of using Metaverse in education*

Q9: How interested are you in receiving training or professional development on how to effectively use Metaverse technologies in education?

The participants' responses were:

- Very interested (91; 54%)
- Interested (56; 33%)
- Neutral (17; 10%)
- Not interested (4; 3%)

The responses to Q9 show a strong interest among participants in receiving training on the effective use of metaverse technologies in education. A majority-91 respondents (54%)-reported being very interested, while an additional 56 respondents (33%) expressed interest. Together, this indicates that nearly 87% of respondents are positively inclined toward professional development in this area. Only a small proportion reported neutrality (10%) or lack of interest (3%). This suggests that although Meta-verse technologies are still emerging, there is substantial motivation among educators to build the necessary skills and knowledge to integrate these tools into teaching and learning.

Q10: Would you be willing to participate in pilot programs to explore metaverse technologies in your teaching?

Responses to this question reveal that 154 participants (91%) are willing to participate in pilot programs exploring the integration of metaverse technologies in teaching. This demonstrates a strong interest among the majority of respondents in learning about and applying metaverse technologies in education.

Q11: In your opinion, how important is it for universities to invest in metaverse technologies to enhance future educational practices?

The participants' responses were:

- Very important (89; 53%)
- Important (53; 32%)
- Neutral (19; 11%)
- Not important (7; 4%)

The responses to this question indicate that participants perceive significant importance in universities investing in metaverse technologies to advance future educational practices. A total of 89 respondents (53%) consider such investment very important, with an additional 53 respondents (32%) rating it as important. Together, this reflects that 85% of participants view investment in immersive technologies as a key factor for enhancing education.

Q12: Please share any additional thoughts or comments regarding the use of metaverse in education.

This was an open-ended question in which participants were asked to provide feedback on the use of metaverse in education. Their responses are summarized as follows:

The responses indicate a strong interest in using metaverse technologies in education, with participants highlighting their potential to enhance student engagement, interaction, creativity, and experiential learning. Many see immersive tools as valuable for bridging geographical gaps, fostering collaboration, and providing hands-on practice through simulations, particularly in fields such as medicine, architecture, engineering, and media studies. Several respondents emphasized the importance of utilizing metaverse technologies to enhance the educational process and called for professional development, workshops, and capacity-building to ensure effective adoption.

At the same time, participants noted several challenges to widespread implementation, including high costs, infrastructure limitations, content preparation, and digital literacy gaps among students and staff. Concerns were also raised about economic sustainability, reliance on large tech

companies, and equitable access. Overall, while the metaverse is seen as a promising tool for enhancing learning experiences, respondents stressed that its successful integration requires careful planning, appropriate training, and strategies to ensure accessibility, inclusivity, and alignment with learning outcomes.

To conclude this section a road map for implementing metaverse in education can be proposed as follows for educators:

To conclude this section, a roadmap for implementing metaverse technologies in education can be proposed for educators as follows:

1. Gradual integration: Begin with a single class or module before expanding to larger-scale adoption, allowing time to evaluate effectiveness and address challenges.
2. Professional development: This is a critical step in successfully adopting metaverse technologies in education
3. Collaboration focus: Design learning activities that enhance the metaverse's collaborative features, such as group projects, virtual labs, and peer mentoring.
4. Assessment strategies: Develop evaluation methods designed to immersive environments, including performance-based assessments, simulations, and experiential tasks.

For policy makers, the following actions are recommended:

1. Infrastructure investment: Support high-speed internet, VR/AR devices, and cloud-based platforms for institutions.
2. Standards and guidelines: Create frameworks for safe, ethical, and effective use of metaverse tools.
3. Cross-institution collaboration: Facilitate partnerships between universities and tech providers to share resources and best practices.

## 5. CONCLUSION AND FUTURE WORK

This study has explored the potential of using metaverse as a transformative force in the educational landscape, particularly within the context of GCC higher education institutions. The analysis, which combines a review of global literature with an original regional survey, highlights a landscape of significant opportunities alongside practical challenges.

The findings confirm the metaverse's considerable promise for creating immersive, engaging, and collaborative learning environments. Empirical evidence from the literature demonstrates

its efficacy in improving learning outcomes, boosting student motivation, and fostering the development of thinking skills. Tools like VR simulations, AR/MR applications (e.g., Microsoft HoloLens), and dedicated platforms (e.g., ENGAGE, Spatial) offer novel ways to transcend physical and temporal limitations, enabling virtual labs, field trips, and interactive scenarios previously unimaginable in traditional settings.

The responses to the survey demonstrate considerable interest in the adoption of metaverse technologies in education, with participants emphasizing their potential to boost student engagement, interaction, creativity, and experiential learning. Many highlighted the value of immersive tools in bridging geographical distances, promoting collaboration, and enabling hands-on practice through simulations, especially in disciplines such as medicine, architecture, engineering, and media studies. Respondents also stressed the need for professional development, workshops, and capacity-building to support effective implementation.

At the same time, several challenges were identified, including high costs, limited infrastructure, content preparation demands, and gaps in digital literacy among both students and staff. Concerns were also expressed regarding economic sustainability, dependence on major technology companies, and equitable access. Overall, while the metaverse is recognized as a promising avenue for enhancing learning experiences, participants underscored that successful integration requires careful planning, targeted training, and strategies to ensure inclusivity, accessibility, and alignment with learning outcomes.

Nevertheless, integrating the metaverse into education faces obstacles that go far beyond financial constraints. Concerns around data privacy, cybersecurity, potential overuse, and social isolation raise critical ethical and health questions that require careful attention through robust governance and policy frameworks. In addition, the effectiveness of this transition largely depends on teacher preparedness, highlighting the pressing need for extensive professional development and training initiatives to ensure educators are equipped to manage and thrive within these complex virtual learning environments.

To unlock the educational potential of the metaverse, this study provides a comprehensive assessment and key actionable strategies. These include adopting a gradual integration process, investing in educator training and technological infrastructure, and fostering the creation of common

standards and collaborative projects.

Future research should employ empirical methods to quantitatively and qualitatively assess the impact of metaverse integration. This would

involve implementing a controlled, metaverse-supported learning environment and rigorously evaluating its effects on students, teachers, and academic outcomes.

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