



**SHORT COMMUNICATION**

## Educational Horizons of the Metaverse: Vision, Opportunities, and Challenges

### Horizontes educativos del metaverso: Visión, oportunidades y retos

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#### ABSTRACT

The onset of the COVID-19 pandemic prompted a profound reconsideration of our approaches to teaching and learning. The metaverse, blending 3D digital realms with the intersection of reality and the virtual landscape, has emerged as a prospective frontier in education, offering substantial promise. Despite its potential, scant attention has been devoted in current research to examining the metaverse through the lens of education, marking it as a relatively unexplored domain. In this article, we commence by presenting the conceptualizations of the metaverse, delving into its inception, definitions, and common attributes. Subsequently, a precise delineation of the metaverse in an educational context is articulated, accompanied by an elaborate framework that undergoes thorough exploration of its distinctive features. We expound upon four conceivable applications of the metaverse in education, elucidating the rationale and providing illustrative cases for each: blended learning, language acquisition, competence-based education, and inclusive educational practices. Our primary discoveries indicate that the terms “education,” “application,” and “metaverse” appeared with the highest frequency and demonstrated interconnectedness. Upon analysis, it becomes evident that concepts like “challenge,” “teaching,” and “knowledge” have not received exhaustive research attention. Concluding our exploration, we put forth a spectrum of research topics that are pertinent to the intersection of the metaverse and education, serving as potential avenues for future scholarly investigations.

**Keywords:** Metaverse; Education; Blended Learning; Language Acquisition.

#### RESUMEN

La aparición de la pandemia de COVID-19 ha provocado una profunda reconsideración de nuestros planteamientos en materia de enseñanza y aprendizaje. El metaverso, mezcla de reinos digitales tridimensionales con la intersección de la realidad y el paisaje virtual, ha surgido como una posible frontera en la educación que ofrece grandes promesas. A pesar de su potencial, en la investigación actual se ha prestado escasa atención al estudio del metaverso desde el punto de vista de la educación, lo que lo convierte en un ámbito relativamente inexplorado. En este artículo, comenzamos presentando las conceptualizaciones del metaverso, profundizando en sus inicios, definiciones y atributos comunes. Posteriormente, se articula una delimitación precisa del metaverso en un contexto educativo, acompañada de un marco elaborado que se somete a una exploración minuciosa de sus características distintivas. Exponemos cuatro aplicaciones concebibles del metaverso en la educación, elucidando los fundamentos y proporcionando casos ilustrativos para cada una de ellas: aprendizaje combinado, adquisición de idiomas, educación basada en competencias y prácticas educativas inclusivas. Nuestros principales descubrimientos indican que los términos “educación”, “aplicación” y “metaverso” aparecieron con la mayor frecuencia y demostraron estar interconectados. Tras el análisis, se hace evidente que conceptos como “reto”, “enseñanza” y “conocimiento” no han recibido

una atención exhaustiva por parte de la investigación. Como conclusión de nuestro análisis, proponemos una serie de temas de investigación pertinentes para la intersección entre el metaverso y la educación, que pueden servir como posibles vías para futuras investigaciones académicas.

**Palabras clave:** Metaverso; Educación; Aprendizaje Combinado; Adquisición De Idiomas.

## INTRODUCTION

The inception of the Metaverse dates back to 1992, gaining prominence notably through its portrayal in the film *Ready Player One*.<sup>(1)</sup> Functioning as a virtual realm intricately intertwined with reality, the Metaverse strives to construct a digitized environment comprising digital media. The fusion of actual and virtual domains signifies the potential of virtuality to exert influence on reality, permeating everyday activities and economic endeavours. Within this literary work, individuals enjoyed unrestricted entry into a three-dimensional space mirroring reality, facilitated by digital agents known as avatars, fostering interactive engagements. Subsequently, spanning the following thirty years, the metaverse concept found increasingly vivid portrayals in the realm of science fiction cinema, exemplified by productions like *Ready Player One*, *Lucy*, and *The Matrix*.<sup>(2)</sup>

Mark Zuckerberg revealed his intentions to construct a "metaverse" for Facebook—an immersive digital realm where individuals can express themselves, and engage in work, recreation, and social interactions, often facilitated through avatars and embodied experiences, commonly through the use of headsets or glasses.<sup>(3)</sup>

The year 2021 marked the inception of what is now recognized as the inaugural year of the metaverse.<sup>(4)</sup> Amidst the burgeoning global research on the metaverse, it has garnered acclaim as an upcoming educational trend with substantial potential.<sup>(5)</sup> Nonetheless, the existing body of literature has seldom delved into the metaverse from an educational standpoint, instead concentrating primarily on disparate discussions of metaverse-related technologies in the realm of education.<sup>(6)</sup> Given its emergent nature, a significant portion of educational researchers may find themselves unfamiliar with the metaverse, its constituent elements, and its potential applications within the educational domain.

This paper seeks to perform a systematic literature review on the integration of the Metaverse in education. The noteworthy contributions of this article are outlined below.

- We present an intricate framework for the metaverse in education, delving into a comparative analysis of metaverse-based learning features in contrast to traditional in-person classroom learning and screen-based remote learning.
- We provide an in-depth exploration of the attributes of conventional education, the Metaverse, and their amalgamation. By outlining the transformative potential of education aided by the Metaverse, we shed light on the forthcoming changes in this new era. Additionally, we delve into the reciprocal influence, discussing how the evolving education model will actively contribute to the advancement of the Metaverse.
- Additionally, we explore potential applications, challenges, and future research topics surrounding the integration of the metaverse in education.

The subsequent sections of this paper are structured as follows: Section 2,3 and 4 engages in discussions to articulate the concept of "the metaverse in education" and introduces a framework delineating its application in educational settings. Furthermore, it conducts a comparative analysis of the features of metaverse-based learning vis-à-vis traditional in-person classroom learning and screen-based remote learning. Section 5 delves into the depiction of potential applications of the metaverse in education, accompanied by rationale and illustrative cases. In Section 6, the focus shifts to an exploration of the challenges presented by the metaverse in educational contexts. Lastly, Section 7 presents a diverse array of research topics related to the metaverse in education, offering potential avenues for future studies.

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## DEVELOPMENT

### *Metaverse in Education*

As scholars have emphasized, education stands out as one of the foremost and highly promising applications of the metaverse in the foreseeable future. Our perspective aligns with the notion that the metaverse serves as a novel educational environment.<sup>(7)</sup> The metaverse in education can be conceptualized as an augmented educational environment, integrating metaverse-related technologies with elements from both virtual and real educational landscapes.<sup>(8)</sup> This integration empowers learners to seamlessly enter educational settings using wearable devices, transcending the constraints of time and location. Moreover, it facilitates real-time interactions through digital identities across a spectrum of entities.

In the contemporary digital landscape, the integration of the metaverse in education has gained unprecedented

relevance, particularly in the aftermath of the COVID-19 pandemic. The pandemic necessitated a radical shift in traditional educational paradigms, compelling institutions and educators to explore innovative and resilient solutions. The metaverse, a dynamic and immersive digital space, emerged as a compelling avenue to address the challenges imposed by the pandemic on the education sector. One notable aspect of the metaverse in education is its potential to transcend the limitations of physical classrooms. With the ability to create interactive and engaging virtual environments, the metaverse allows educators to design immersive learning experiences that go beyond the constraints of traditional brick-and-mortar settings. This becomes especially crucial in a post-pandemic world where flexibility and adaptability in educational delivery are paramount. Moreover, the metaverse in education provides a unique opportunity to enhance the accessibility of learning. Students can participate in educational activities from various locations, breaking down geographical barriers. This is particularly relevant in a post-COVID era where remote and hybrid learning models have become integral components of the educational landscape.<sup>(9)</sup>

The metaverse also introduces novel possibilities for collaborative learning and social interaction. Students can engage in virtual classrooms, interact with peers through avatars, and participate in collaborative projects within the immersive digital space. This not only fosters a sense of community but also cultivates digital literacy and communication skills that are increasingly essential in the evolving landscape of education and work. However, challenges and considerations accompany the incorporation of the metaverse in education. Issues such as digital equity, privacy concerns, and the need for effective pedagogical strategies within virtual environments must be addressed to ensure an inclusive and secure learning experience. The metaverse in education represents a transformative frontier in the post-COVID digital world. As education continues to evolve, the metaverse offers an innovative pathway to reimagine and enhance the learning experience, providing educators and learners with tools to navigate the complexities of a rapidly changing educational landscape.<sup>(10)</sup> While challenges persist, the potential benefits of the metaverse in education underscore its significance as a pivotal force shaping the future of learning in the digital age.

### ***The Framework of the Metaverse in Education***

In the existing body of literature,<sup>(11)</sup> introduced a metaverse framework encompassing potential core components, ranging from hardware and computing to networking, virtual platforms, interchange tools and standards, payments services, content, services, and assets. The rationale behind this framework was briefly outlined. However, there is a lack of detailed explanations regarding the practical implementation of the metaverse.<sup>(12)</sup> Building upon this,<sup>(13)</sup> further delineated the metaverse into three fundamental components, namely hardware, software, and content. Additionally, they introduced three distinct approaches—user interaction, implementation, and application—providing a comprehensive overview of the metaverse in a broader context. Notably, scarce contributions to the metaverse in education have been put forth by.<sup>(14)</sup>

Exploring the provision of educational services and potential applications of the metaverse from an AI perspective, researchers have primarily centred their discussions on the roles played by AI in educational settings. However, it's crucial to recognize that the metaverse is a convergence of various technologies, rather than being solely propelled by a single technology such as AI. Given the limited studies delving into the metaverse for educational purposes, we derive insights from existing research papers to propose a comprehensive framework for the metaverse in education. In Figure 1, we present the outlined framework for the metaverse in education, delving into its key components within this section. The genesis of the metaverse is intricately tied to technological advancements.<sup>(11)</sup> In essence, the realization of the metaverse in education hinges on the contemporary maturity of diverse technologies. Consequently, a diverse range of technologies assumes the role of the metaverse's infrastructure in education, providing substantial support for components in both the physical and metaverse realms. The ensuing discussion navigates through each component of the technological infrastructure underpinning the metaverse in education.

#### **i. High-speed communication and networks**

The foundational prerequisites for establishing and sustaining the metaverse world encompass wireless communication and advanced high-speed networks, exemplified by technologies like 5G or the anticipated 6G. The seamless functioning and realization of the metaverse hinge significantly upon the robust capabilities afforded by these network infrastructures.

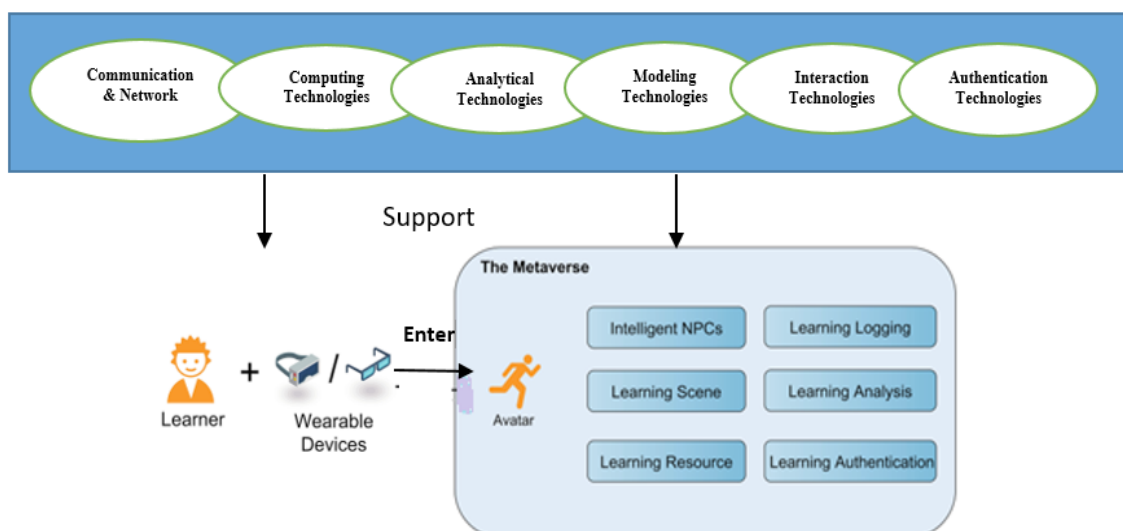


Figure 1. Metaverse educational framework

## ii. Computing technologies Top of Form

The metaverse necessitates the integration of sophisticated computing technologies to facilitate its intricate functionalities. These technologies serve as the backbone for processing vast and intricate data sets, powering the immersive experiences, and enabling seamless interaction within the virtual realm. In essence, the demand for computing technologies in the metaverse underscores their pivotal role in shaping and sustaining this dynamic digital environment. The computational backbone not only supports the infrastructure but also contributes to the immersive and interactive nature of the metaverse, making it an indispensable element in its overall functionality and user experience.

## iii. Analytical technologies

As analytical technologies undergo swift advancements, tools like artificial intelligence (AI), big data, and text mining emerge as valuable assets in the realm of education. This rapid development opens avenues for innovative applications that enhance educational processes and outcomes. AI, with its capacity for intelligent automation and personalized learning, transforms how educators deliver content and tailor educational experiences. Big data enables the extraction of meaningful insights from vast datasets, informing decision-making and strategic planning in education. Simultaneously, text mining facilitates the extraction of valuable information from textual sources, contributing to a more nuanced understanding of educational trends and patterns.<sup>(15)</sup> Together, these technologies not only signify a technological evolution in education but also hold the potential to revolutionize how educators analyze, interpret, and adapt to the ever-changing landscape of educational practices.

## iv. Interaction technologies

The metaverse offers a transformative potential in education by providing learners with authentic and embodied learning experiences, facilitated by advanced interaction technologies. Unlike traditional educational settings, the metaverse transcends conventional boundaries and enables learners to engage with content in immersive, realistic environments. Interaction technologies play a pivotal role in shaping this experience, allowing learners to actively participate, manipulate, and explore virtual spaces. These technologies, which may include virtual reality, augmented reality, and other interactive tools, contribute to a more sensorially rich and engaging learning environment.<sup>(16)</sup> In the metaverse, learners can go beyond passive reception of information and instead interact with educational content in a manner that closely mirrors real-world scenarios.<sup>(17)</sup> This not only enhances retention and understanding but also fosters a deeper connection to the subject matter. Moreover, the authenticity of experiences within the metaverse contributes to practical skill development, as learners can apply knowledge in simulated contexts.

## v. Authentication technologies

Authentication technologies play a critical role in ensuring the security, privacy, and integrity of interactions within the metaverse. In the complex digital landscape of the metaverse, where virtual and real-world elements intertwine, robust authentication mechanisms become paramount. These technologies are designed to verify

and validate the identity of users, preventing unauthorized access and protecting sensitive information. In the metaverse, authentication technologies serve as gatekeepers, controlling access to virtual spaces, digital assets, and interactive experiences. Biometric authentication, cryptographic methods, and multi-factor authentication are examples of technologies employed to bolster security within the metaverse. These mechanisms not only safeguard user identities but also contribute to the overall trustworthiness of virtual environments.

#### vi. Smart wearable device

The integration of smart wearable devices in metaverse education represents a dynamic convergence of technology to enhance the learning experience. Smart wearables, such as augmented reality (AR) glasses, haptic feedback devices, and biometric sensors, introduce a new dimension to education within the metaverse.

Smart wearables facilitate a more immersive and interactive learning environment. For instance, AR glasses can overlay digital information onto the real world, providing students with contextual and augmented content during educational experiences. This creates a seamless integration of virtual elements with the physical surroundings, enhancing the authenticity and engagement of educational activities.

#### vii. Avatar

In the metaverse, the avatar serves as the digital manifestation or representation of the player character, playing a central role in shaping the user's experience within virtual environments. Essentially, it acts as the conduit through which users navigate and interact with the metaverse, embodying their presence in the digital realm. Avatars in the metaverse are more than mere graphical representations; they encapsulate the user's identity, and preferences, and often reflect the user's creativity and individuality. Users can customize their avatars, choosing distinct appearances, clothing, accessories, and even behaviours, contributing to a personalized and immersive experience. The significance of avatars extends beyond mere aesthetics. They become the user's interface for communication, expression, and interaction with other users and the virtual surroundings. Avatars facilitate social engagement, collaboration, and the formation of digital communities within the metaverse.<sup>(18)</sup> They become the digital extensions of users, allowing them to express themselves, establish a digital presence, and forge connections with others.

However, the concept of avatars in the metaverse also raises considerations related to identity, representation, and user behaviour. Users may grapple with questions of authenticity and self-expression, while the behaviour of avatars can influence the dynamics of virtual interactions and the formation of online communities.

### ***Features of The Metaverse in Education***

The features of the metaverse in education encapsulate a transformative set of elements that redefine traditional learning paradigms. In the educational context, the metaverse introduces a multifaceted landscape with distinctive characteristics that enhance the overall learning experience. One key feature is the immersive nature of the metaverse. Students are no longer passive recipients of information but active participants in virtual environments. This immersion is facilitated by advanced technologies such as virtual reality (VR) and augmented reality (AR), allowing learners to engage with educational content in three-dimensional, dynamic spaces. Interactivity stands out as another prominent feature.<sup>(19)</sup> The metaverse fosters real-time collaboration and communication among students and educators. Learners can interact with digital content, manipulate virtual objects, and engage in collaborative projects, transcending the limitations of traditional classroom settings. Customization and personalization are integral features of the metaverse in education. Educational experiences can be tailored to individual learning styles, preferences, and pace, providing a personalized learning journey for each student. This adaptability enhances engagement and comprehension, addressing the diverse needs of learners. The metaverse also promotes accessibility, breaking down geographical barriers and offering educational opportunities to a global audience. Students from different parts of the world can converge in virtual classrooms, fostering a diverse and inclusive learning environment. However, challenges accompany these features, including concerns about digital equity, privacy, and the need for effective pedagogical strategies within virtual spaces. Striking a balance between technological innovation and ensuring equitable access to educational opportunities is crucial in harnessing the full potential of the metaverse in education.<sup>(20)</sup>

The features of the metaverse in education mark a paradigm shift in how learning is conceptualized and experienced. The immersive, interactive, customizable, and accessible nature of the metaverse holds significant promise for reshaping education in a way that aligns with the evolving needs and expectations of learners in the digital age.

### ***Future Potential Applications of the Metaverse in Education***

The future potential applications of the metaverse in education herald a transformative era in the way knowledge is disseminated, acquired, and experienced. As we peer into the horizon of educational possibilities within the metaverse, several groundbreaking applications come into focus. One prominent avenue is the

augmentation of traditional learning methods through immersive experiences. Virtual classrooms within the metaverse could replicate real-world environments, enabling students to engage in hands-on experiences and simulations that transcend the limitations of physical classrooms. This could revolutionize fields such as science, engineering, and medicine, where practical applications are crucial for understanding complex concepts. Another prospective application lies in personalized learning experiences. The metaverse, with its capacity for customization, could tailor educational content to individual learning styles, preferences, and paces.<sup>(4)</sup> Adaptive learning algorithms within the metaverse could dynamically adjust coursework, ensuring that each learner receives content in a manner optimized for their understanding. Collaborative learning is poised to undergo a paradigm shift with the metaverse. Virtual spaces could facilitate seamless teamwork among students, irrespective of geographical distances. This collaborative potential extends beyond synchronous interactions, enabling asynchronous teamwork and global collaboration on projects, fostering a rich tapestry of diverse perspectives. Furthermore, the metaverse could serve as a platform for vocational training and skill development. Simulated work environments within virtual spaces could provide hands-on training for various professions, offering a safe and controlled setting for learners to hone practical skills.

However, as we contemplate these potential applications, considerations regarding digital equity, privacy, and the evolving role of educators in this technologically enriched landscape become imperative. Striking a balance between innovation and ethical considerations will be essential to fully realize the potential benefits of the metaverse in education. In essence, the future potential applications of the metaverse in education hold the promise of reshaping the educational landscape, providing learners with unprecedented opportunities for immersive, personalized, and collaborative learning experiences.<sup>(21)</sup> As technological advancements continue, the metaverse stands poised to redefine the boundaries of education, unlocking new possibilities for both educators and learners.

### ***Challenges of The Metaverse in Education***

The evolution of the metaverse in education hinges on effectively overcoming these challenges to create a learning environment that is both inclusive and impactful. While the metaverse offers novel perspectives for educational advancement, a cautious stance is essential regarding the array of challenges it presents, whether for educational applications or other purposes. This section will predominantly delve into four key challenges associated with integrating the metaverse into educational settings.

- a. **Digital Equity and Accessibility:** The challenges of the metaverse in education begin with issues of digital equity and accessibility. Not all students have equal access to the necessary devices and high-speed internet connections required for seamless participation in virtual learning environments. This digital divide can exacerbate educational inequalities, limiting the inclusivity of metaverse-based education.
- b. **Privacy Concerns:** Privacy emerges as a significant challenge as educational activities in the metaverse involve the collection and processing of personal data. Safeguarding sensitive information and ensuring that students have control over their digital identities becomes crucial. Striking a balance between personalized learning experiences and protecting privacy is a complex task.<sup>(22)</sup>
- c. **Pedagogical Integration:** Integrating effective pedagogical strategies into the metaverse poses a challenge. The shift from traditional teaching methods to virtual, immersive experiences requires educators to adapt and develop new instructional approaches. Ensuring that educational objectives are met within the metaverse environment without compromising the quality of instruction is a continual challenge.
- d. **Technical Infrastructure:** The successful implementation of the metaverse in education is contingent on robust technical infrastructure. Educational institutions need reliable systems that can support the bandwidth and computational requirements of virtual learning environments.<sup>(23)</sup> Insufficient infrastructure may lead to latency issues, disrupting the immersive experiences promised by the metaverse.
- e. **User Training and Digital Literacy:** Both educators and students need adequate training to navigate and maximize the benefits of the metaverse. Developing digital literacy skills becomes essential to leverage the full potential of virtual learning environments. Addressing the learning curve associated with metaverse technologies is crucial for widespread adoption and effective utilization.
- f. **Cost Implications:** The financial implications of incorporating metaverse technologies into education can be considerable. Acquiring the necessary hardware, software, and training resources may pose a financial burden for educational institutions. This raises questions about the scalability and affordability of metaverse-based education, especially for institutions with limited budgets.
- g. **Content Creation and Quality Assurance:** Ensuring the creation of high-quality educational content within the metaverse is a challenge.<sup>(24)</sup> Developing immersive and engaging materials requires

expertise in both educational content creation and virtual world design.<sup>(25)</sup> Maintaining a standard of quality across diverse virtual learning environments is an ongoing challenge for educators and content creators.

### ***Future Research Topics of the Metaverse in Education***

As outlined in the preceding sections, the metaverse has the potential to wield substantial influence in the realm of education.<sup>(26)</sup> The continuous advancement of emerging technologies opens up diverse possibilities for incorporating the metaverse into educational practices. Despite the current scarcity of studies specifically addressing the metaverse in education, there is a firm belief that scholarly attention in this domain will experience rapid growth in the forthcoming years.<sup>(27)</sup> To pave the way for future research endeavors, this section comprehensively explores various potential research avenues concerning the metaverse's application in education.

- a. **Ethical Implications of Educational Metaverse:** Exploring the ethical dimensions of the metaverse in education constitutes a crucial research avenue. This involves investigating issues such as data privacy, digital identity, and the ethical use of immersive technologies in educational settings.<sup>(28)</sup> Understanding and addressing ethical considerations will be vital as the metaverse continues to evolve.
- b. **Impact of the Metaverse on Learning Outcomes:** A critical research focus should examine the impact of the metaverse on learning outcomes. This involves assessing the effectiveness of immersive and interactive learning experiences in comparison to traditional methods. Understanding how the metaverse influences knowledge retention, skill development, and overall educational achievement is essential for shaping future educational practices.
- c. **Teacher Training and Professional Development in the Metaverse:** Investigating effective strategies for training educators and facilitating their professional development within the metaverse is paramount. This includes understanding how teachers can adapt their pedagogical approaches to leverage the metaverse for enhanced teaching and learning. Examining the skills and knowledge required for effective metaverse-based instruction is a key research topic.<sup>(29)</sup>
- d. **Digital Inclusion and Accessibility in Metaverse Education:** Addressing digital equity and accessibility challenges within the metaverse is a crucial area of research. This involves exploring how to ensure that all students, regardless of socio-economic factors, have equitable access to metaverse-based educational resources. Identifying barriers and proposing solutions for digital inclusion is vital for creating an inclusive educational metaverse.
- e. **Integration of Artificial Intelligence (AI) in Metaverse Education:** Investigating the synergies between artificial intelligence (AI) and the metaverse in education is a forward-looking research topic. This involves exploring how AI can enhance personalized learning experiences, adaptive assessments, and intelligent tutoring systems within the metaverse. Understanding the potential of AI integration can contribute to the refinement of metaverse-based educational technologies.
- f. **Cultural and Societal Impacts of Metaverse Learning Environments:** Examining the cultural and societal implications of metaverse-based education is essential. Research in this area would explore how different cultures perceive and interact with metaverse learning environments. Understanding the societal impact, including issues related to identity, diversity, and cultural representation, is crucial for creating inclusive metaverse educational experiences.
- g. **Long-term Effects on Student Well-being and Mental Health:** Investigating the long-term effects of metaverse-based education on student well-being and mental health is a pressing research concern. This involves examining factors such as screen time, social interactions, and the psychological impact of immersive virtual environments. Identifying potential challenges and benefits to student mental health is essential for fostering a healthy educational metaverse.
- h. **Security and Privacy in Metaverse Learning Environments:** Delving into the security and privacy aspects of metaverse learning environments is critical. Research should focus on developing robust security measures to protect user data, prevent unauthorized access, and ensure a safe online learning environment. Addressing potential vulnerabilities and proposing effective security solutions is imperative for the sustainable development of metaverse education.

In pursuing these diverse research topics, scholars and educators can contribute to the nuanced understanding and responsible development of the metaverse in education, fostering a landscape that is not only technologically advanced but also ethical, inclusive, and conducive to positive learning outcomes.

## CONCLUSION

While we have attempted to offer a comprehensive exploration of the Metaverse revolution in education, it is acknowledged that certain technologies or concepts may not have been explicitly covered in this paper. This article is intended to serve as a catalyst for researchers and practitioners, stimulating contemplation on potential research directions for delving deeper into the integration of the Metaverse in education. The overview provided herein illustrates the intersection of education with the Metaverse. A wealth of research and case studies attests to the viability of integrating with the Metaverse as a method to foster a more equitable educational landscape. In breaking down numerous barriers, emerging technologies offer solutions to challenges that are often intricate to address in the physical realm. Top of Form

The rapid advancements in high-speed communication, computing, artificial intelligence (AI), and virtual technologies have opened up expansive possibilities for the development of the metaverse. According to Gartner's projections, approximately 30 % of individuals are anticipated to allocate 2 hours daily to engage in the metaverse for work, entertainment, education, and socialization by the year 2027. Particularly in the realm of education, the metaverse represents a groundbreaking concept when compared to existing educational technologies. As highlighted earlier, the metaverse introduces significant opportunities and innovations to the educational landscape. It holds the potential to surmount several obstacles and limitations inherent in current educational approaches, marking a transformative shift in the educational paradigm. Moreover, sustained attention to the metaverse serves as an indicator of the trajectory and future orientation of education. Consequently, it is foreseeable that an increasing number of educational researchers will actively participate in metaverse-related studies in the imminent future.

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#### **CONFLICT OF INTEREST**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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