

# METaverse IN HIGHER EDUCATION

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## Abstract

The metaverse has significantly changed higher education, providing immersive, interactive, and dynamic learning environments that go beyond the boundaries of the classroom. This emerging digital space includes virtual reality (VR), augmented reality (AR) and other immersive technologies to create virtual campuses, interactive simulations and experiential learning scenarios, fostering hands-on learning in virtual environments. The potential to enhance student engagement, promote collaboration and deliver personalised learning experiences is huge.

This article reviews the potential of the metaverse in higher education, taking into account how these technologies can change teaching methodologies and reshape student experiences. The metaverse allows students to engage in real-world practical scenarios without physical constraints, facilitating deeper understanding through learning-by-doing approaches. It also offers opportunities for global collaboration, allowing students and lecturers to interact across geographical boundaries. The paper also reviews the main challenges associated with the adoption of the metaverse in academia and proposes strategies for integrating the metaverse into university curricula.

Keywords: Metaverse, education, university.

## 1 INTRODUCTION

The metaverse is transforming education at all levels, but its greatest impact is seen in higher education due to its capacity to foster immersive and collaborative learning environments that align with the complex demands of university-level studies. The metaverse is a virtual, interconnected, and immersive digital space where users can interact with one another and with computer-generated environments in real time. It blends elements of augmented reality (AR), virtual reality (VR), and 3D virtual worlds, often incorporating factors of the internet, gaming, and social networking.

These digital technologies create simulated scenarios that provide students with interactive experiences, promoting their safety through risk-free environments and enhancing their problem-solving skills. Universities are evolving, shifting from traditional methodologies to approaches that are more immersive, interactive, and dynamic through the use of the metaverse. However, the implementation of these technologies in education is still in its early stages, and there are relatively few successful implementations and experiences to date. To integrate these technologies effectively in the university context, it is essential to consider several factors, including pedagogical, technical, and social and ethical dimensions.

This article, therefore, reviews the potential of the metaverse in higher education, considering the aforementioned dimensions through a systematic literature review. It explores the main challenges associated with the adoption of the metaverse in academia and, finally, proposes strategies for integrating the metaverse into university curricula.

The paper is structured as follows: After the introduction, Section 2 details the research methodology. This is followed in Section 3 by a characterisation of the pedagogical, technical, social, and ethical dimensions related to the adoption of the metaverse in higher education. This section also proposes strategies for successfully integrating metaverse technologies into university degrees. Finally, the conclusions and future lines of work are outlined in Section 4.

## 2 METHODOLOGY

The research methodology is based on a systematic review of the literature, aimed at conducting various analyses based on the predefined dimensions. The search was carried out through the Web of Science database using the following query: 'metaverse' (Title) AND 'university' OR 'education' OR 'higher' OR 'tertiary' (Title) and Preprint Citation Index (Exclude - Database) and Review Article (Document Types). As the main objective of the article is to obtain a global and aggregated view of the metaverse

dimensions when implemented at university, only the document types: review article were considered, enabling the development of a meta-review. The methodology is summarised in Figure 1.

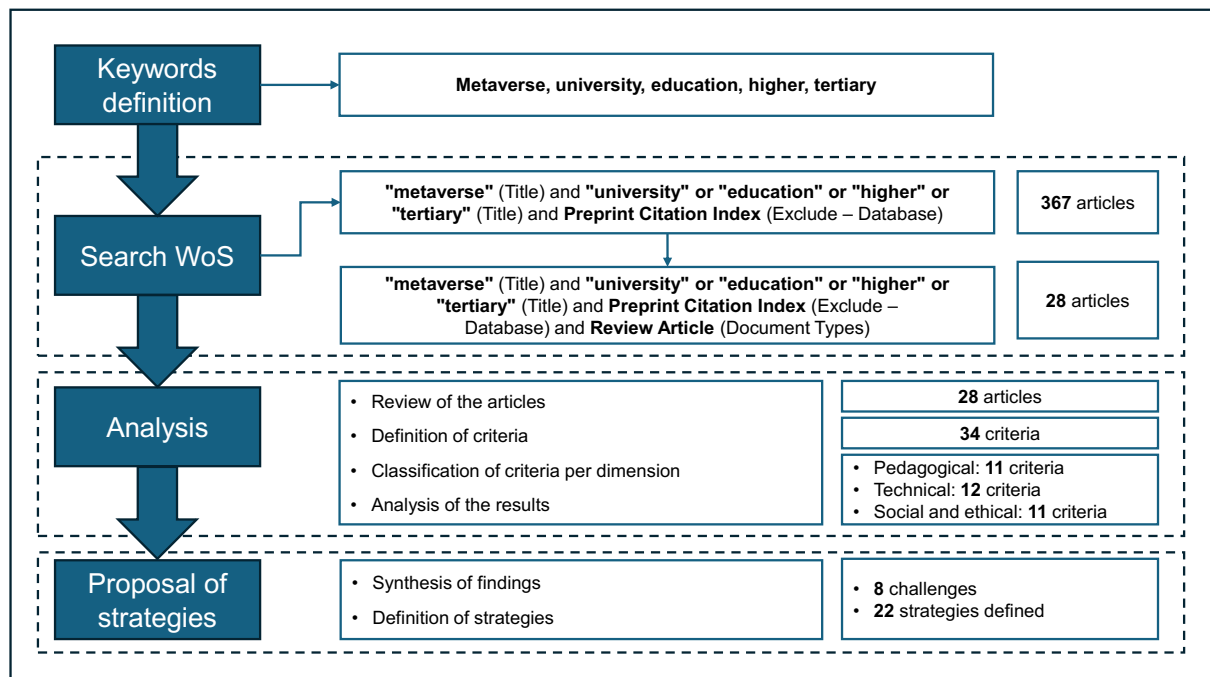


Figure 1. Research methodology.

### 3 RESULTS

Taking into account that the characterisation of the metaverse technologies integration into university is based on three dimensions, the factors used to classify the articles is shown in Table 1.

Table 1. Factors influencing the adoption of metaverse technologies into education.

<i>Pedagogical</i>	
<b>Collaboration</b>	It facilitates collaborative learning by enabling students and educators to interact and work together in shared virtual spaces
<b>Enhanced interaction</b>	It offers richer and more dynamic forms of interaction, allowing students to engage with their peers and instructors and also with virtual objects and environments
<b>Enhanced learning experiences/real world-simulations</b>	It provides opportunities for students to engage in realistic simulations, such as virtual laboratories or role-playing scenarios
<b>Enhanced Understanding</b>	By offering immersive and interactive experiences, the metaverse can help students grasp complex concepts more effectively
<b>Experiential, active and problem-based learning</b>	It supports pedagogical approaches that encourage students to actively engage with content, solve real-world problems, and learn by doing, fostering critical thinking and practical skills
<b>Immersive environment</b>	It creates a sense of presence and engagement, enabling students to fully focus on their learning without external distractions
<b>Interdisciplinary learning</b>	It facilitates the integration of knowledge across disciplines by creating virtual spaces where students from different fields can collaborate, share insights, and work on multidisciplinary projects
<b>Motivation and engagement</b>	Visually rich environments and interactive experiences can boost student motivation and engagement, making learning more enjoyable and effective
<b>Personalised learning</b>	It can adapt to individual students' learning styles, paces, and preferences, providing customised content, feedback, and support to meet their unique educational needs
<b>Safe environment</b>	It provides risk-free spaces where students can experiment, make mistakes, and learn without facing real-world consequences

<i>Technical</i>	
<b>Accessibility</b>	It refers to the ability of all students and educators to access metaverse technologies regardless of disabilities, geographic location, or economic background
<b>Costs and resources</b>	It involves the financial and material investments required to implement metaverse technologies
<b>Integration of Metaverse with existing educational systems</b>	It addresses the challenge of seamlessly incorporating metaverse platforms into current university structures
<b>Internet access and connectivity</b>	It highlights the necessity of reliable, high-speed internet to support the bandwidth demands of immersive metaverse environments
<b>Interoperability</b>	It refers to the ability of different metaverse platforms and tools to work together
<b>Limited adoption</b>	It reflects the slow pace of adoption due to, for example, scepticism or lack of awareness
<b>Scalability</b>	It examines whether metaverse solutions can be expanded to accommodate large numbers of users while maintaining performance, functionality, and user experience
<b>Technical limitations</b>	It covers constraints related to the current state of technology
<b>Technical support/maintenance</b>	It involves the ongoing need for expert personnel to troubleshoot issues and maintain systems
<b>Technological infrastructure</b>	It refers to the hardware, software, and network systems required to implement and support metaverse technologies at scale in universities
<b>Training</b>	It highlights the need for adequate training for both educators and students to effectively use metaverse technologies
<b>Usability and learning curve</b>	It focuses on how intuitive and user-friendly metaverse tools are
<i>Social and ethical</i>	
<b>Data privacy</b>	The use of the Metaverse raises concerns about the privacy of student data, with risks related to data breaches and unauthorised access
<b>Data security</b>	
<b>Digital divide</b>	Refers to the gap between students or institutions that have access to the necessary technology and those that do not
<b>Equity in access</b>	It focuses on ensuring that all students, regardless of socioeconomic background, geographic location, or physical abilities, have equal opportunities to benefit from metaverse technologies in education.
<b>Identity</b>	This aspect examines how students and educators represent themselves in virtual environments, such as through avatars, and the implications for self-expression, inclusivity, and the potential for identity-related challenges (e.g., misrepresentation or stereotyping)
<b>Mental health</b>	It concerns the psychological impacts of prolonged exposure to immersive virtual environments through metaverse technologies
<b>Over-reliance on virtual experiences</b>	It highlights the risk of prioritising virtual interactions and learning over physical experiences
<b>Over-use and addiction</b>	It addresses the potential for excessive use of metaverse technologies, which could lead to behavioural problems and dependency
<b>Resistance to change</b>	It refers to the reluctance of educators, administrators, or students to adopt new metaverse technologies due to a preference for traditional methods
<b>Social interaction and isolation</b>	While the Metaverse enables virtual social interactions, it may also lead to social isolation if students spend too much time in virtual environments, reducing face-to-face interactions
<b>Virtual presence</b>	It describes the sense of "being there" in a virtual environment and its impact on engagement, immersion, and learning outcomes.

### 3.1 Pedagogical dimension

The pedagogical dimension of the metaverse refers to the integration of immersive, virtual environments and tools for educational purposes. In this dimension, the metaverse provides opportunities for students to engage in experiential learning, where they can interact with digital simulations, explore 3D models, collaborate in virtual spaces, and access resources in innovative ways. It also offers an avenue for customised learning, the development of digital literacy, critical thinking, and problem-solving skills. Additionally, it encourages an interdisciplinary approach, combining insights from technology, social sciences, and education to foster a more holistic learning experience and collaboration across diverse geographical locations.

The review of the literature reveals that there are many benefits of implementing metaverse technologies in universities and very few barriers from the pedagogical point of view. The main barriers encountered were in the technical, social and ethical dimensions, while in the pedagogical dimension the only two challenges to be highlighted through the analysis of this meta-review were integration with existing curriculum and content development and integration. For this reason, as shown in Table 2, the main benefits of integrating metaverse technologies into university programs are presented. Each row corresponds to a specific research work identified in the literature review, while the columns identify whether a particular aspect has been addressed or emphasised. A checkmark (✓) means the inclusion or relevance of the corresponding aspect in that research work. Moreover, the factors are listed alphabetically, as are the articles, which are organised by year and then alphabetically by the first author's surname.

Table 2. Benefits of the pedagogical dimension.

	Collaboration	Enhanced interaction	Enhanced learning experiences/realities	Experiential, active and problem-based	Immersive environment	Interdisciplinary learning	Motivation and engagement	Personalised learning	Safe environments
[1]			✓				✓	✓	
[2]	✓	✓	✓					✓	
[3]	✓		✓	✓			✓		
[4]	✓		✓	✓	✓		✓	✓	
[5]		✓	✓				✓	✓	
[6]	✓			✓	✓		✓	✓	
[7]		✓	✓						
[8]	✓			✓	✓				
[9]	✓	✓		✓	✓				
[10]	✓		✓		✓		✓	✓	
[11]				✓				✓	
[12]			✓	✓					
[13]	✓	✓			✓			✓	
[14]	✓	✓		✓	✓				
[15]			✓		✓			✓	
[16]	✓			✓			✓		
[17]	✓			✓	✓				✓
[18]	✓	✓		✓			✓	✓	
[19]			✓		✓		✓		
[20]		✓	✓	✓	✓		✓	✓	
[21]	✓		✓	✓	✓	✓		✓	✓
[22]				✓	✓				
[23]	✓		✓	✓					
[24]	✓		✓						
[25]								✓	
[26]				✓	✓	✓			✓
[27]			✓					✓	
[28]	✓		✓	✓	✓			✓	

It is worth noting that some challenges could fit within the pedagogical dimension, but the review of articles has shown that most studies classify them as this research does. For example, challenges such as resistance to change, motivation, and training could be related to the pedagogical dimension. However, most of the studies analysed have classified them within the social dimension, and for this reason, this work has followed the same logic.

### 3.2 Technical dimension

The technical dimension is characterised in Table 3. This table provides a detailed analysis of key factors influencing the integration of the metaverse into educational systems. These factors include accessibility, costs and resource requirements, internet access and connectivity, and technical considerations such as interoperability, scalability, and infrastructure. Additionally, challenges like limited adoption, usability, training requirements, and technical support are highlighted. This comparative overview facilitates understanding the multifaceted challenges and opportunities in leveraging metaverse technologies for education.

Table 3. Challenges of the technical dimension.

	Accessibility	Costs and resources.	Integration of metaverse with existing educational systems	Internet access and connectivity	Interoperability	Limited adoption	Scalability	Technical limitations	Technical support/maintenance	Technological infrastructure	Training	Usability and learning curve
[1]		✓	✓							✓	✓	
[2]	✓	✓	✓		✓					✓		✓
[3]		✓	✓							✓	✓	
[4]	✓	✓			✓		✓			✓		✓
[5]	✓	✓		✓				✓		✓	✓	
[6]		✓	✓	✓	✓				✓	✓		✓
[7]								✓		✓		
[8]		✓	✓				✓			✓	✓	
[9]	✓	✓	✓							✓	✓	
[10]		✓	✓				✓			✓	✓	
[11]	✓	✓						✓			✓	✓
[12]						✓				✓		
[13]	✓	✓								✓		
[14]		✓		✓	✓		✓	✓			✓	
[15]		✓	✓		✓		✓			✓	✓	
[16]		✓			✓	✓			✓	✓		✓
[17]	✓	✓		✓					✓	✓		✓
[18]		✓		✓				✓		✓	✓	
[19]	✓									✓		
[20]	✓	✓	✓	✓						✓	✓	
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[26]		✓		✓	✓		✓			✓		✓
[27]		✓								✓	✓	
[28]	✓	✓	✓				✓			✓	✓	

### 3.3 Social and ethical dimension

The factors influencing the social and ethical dimension are shown in Table 4. The table outlines key factors such as data privacy, equity in access, mental health, and social interaction, among others.

Table 4. Challenges of the social and ethical dimension.

	Confidentiality	Data privacy	Data security	Digital divide	Equity in access	Identity	Mental health	Over-reliance on virtual experiences	Over-use and addiction	Resistance to change	Social interaction and isolation	Virtual presence
[1]		✓	✓	✓	✓	✓					✓	✓
[2]		✓	✓		✓		✓		✓		✓	
[3]		✓	✓		✓				✓			
[4]		✓	✓	✓	✓						✓	
[5]		✓	✓		✓		✓				✓	
[6]		✓	✓		✓						✓	
[7]		✓			✓							
[8]	✓	✓	✓		✓		✓	✓				
[9]		✓	✓		✓				✓		✓	
[10]		✓	✓	✓	✓				✓		✓	✓
[11]		✓							✓		✓	
[12]		✓	✓		✓						✓	
[13]		✓		✓	✓						✓	
[14]		✓	✓		✓							
[15]		✓	✓		✓							
[16]		✓	✓	✓	✓		✓				✓	
[17]		✓	✓	✓	✓		✓		✓		✓	
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[19]		✓	✓						✓			
[20]		✓	✓		✓	✓						✓
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[22]	✓	✓	✓		✓							
[23]		✓	✓		✓							
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[26]		✓	✓		✓							
[27]				✓			✓				✓	
[28]		✓	✓		✓						✓	✓

### 3.4 Strategies proposal for integrating metaverse technologies in education

The most common and frequently cited challenges of adopting metaverse technologies in education, as shown in Figure 2, span across pedagogical, technical, and social dimensions.

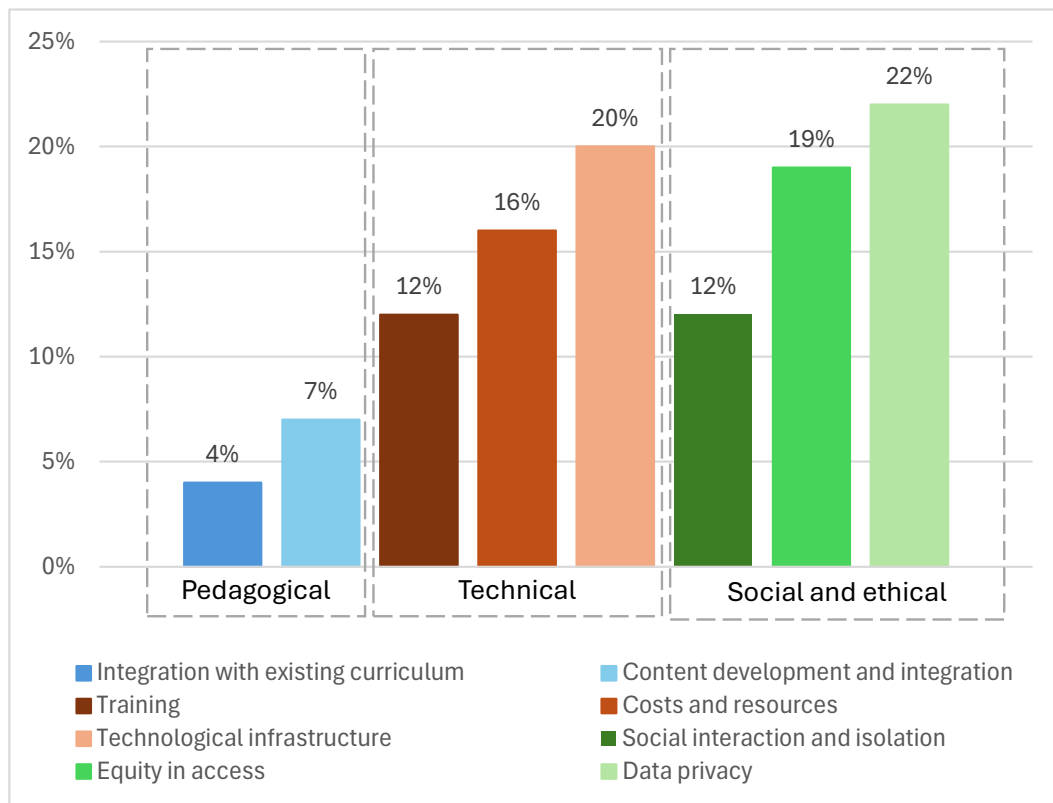


Figure 2. The most cited challenges to the adoption of the metaverse.

These include, from the pedagogical point of view, difficulties in integrating metaverse tools with existing curricula and the resource-intensive nature of content development. From the technical viewpoint, the significant training required for educators and students to effectively use these technologies is one of the top 3 main challenges. Additionally, universities face high costs of implementation and the need for robust technological infrastructure. Finally, concerns about equity in access, data privacy, and the potential for social isolation are social and ethical challenges that should be considered when adopting metaverse technologies.

Addressing these challenges is critical to ensure the successful and inclusive adoption of metaverse technologies in higher education. For this reason, Table 5 shows a proposal of strategies addressed to the most cited challenges to the adoption of the metaverse in education.

Table 5. Proposal of strategies for integrating metaverse in education.

Pedagogical challenges	
Integration with existing curriculum	
Align metaverse technologies with learning outcomes	Design metaverse activities that directly support existing course objectives and learning goals
Create modular content	Develop flexible, plug-and-play virtual modules that can be easily incorporated into diverse subjects
Collaborative curriculum redesign	Engage educators and experts from industry to co-develop metaverse-integrated courses
Content development and integration	
Use of open-source tools and platforms	Use existing metaverse platforms to reduce development time and costs while allowing customisation
Encourage interdisciplinary collaboration	Combine expertise and know-how from educators, students, industry experts and designers to create high-quality, interactive content
Provide university support	Offer grants or incentives for educators to develop metaverse content

<i>Technical challenges</i>	
<i>Training</i>	
Conduct university educators and student workshops	Provide hands-on training sessions to build confidence and familiarity with metaverse tools
Develop online learning resources	Create self-paced tutorials and guides for educators and students
Establish a support team	Form a dedicated technical team to assist with troubleshooting and onboarding
<i>Costs and resources</i>	
Search for external funding	Apply for grants to fund metaverse initiatives
Adopt scalable solutions	Firstly, implement smaller pilot programs to test feasibility before expanding to full-scale implementations
Use shared resources	Intra-collaboration among different departments to share infrastructure, content, and training resources
<i>Technological infrastructure</i>	
Upgrade technological infrastructure	Invest in high-speed internet, servers, and compatible devices to support metaverse applications.
Optimise accessibility	Focus on lightweight applications that can run on existing hardware to minimize additional investments
<i>Social and ethical challenges</i>	
<i>Social interaction and isolation</i>	
Foster collaboration in virtual spaces	Design group-based activities to encourage interaction and teamwork within the metaverse
Combine physical and virtual learning	Implement hybrid models that combine in-person and virtual sessions to reduce isolation
Promote well-being initiatives	Offer mental health support to address the potential for isolation
<i>Equity in access</i>	
Provide loan programs for hardware	Offer VR headsets and other required equipment to students in need through loan or subsidy programs. Rental of the devices is also another strategy to be promoted
Ensure cross-platform compatibility	Use metaverse tools that work on a variety of devices, including lower-cost options like smartphones or tablets
<i>Data privacy</i>	
Implement robust data protection policies	Ensure compliance with regulations like GDPR and establish clear guidelines for data usage
Adopt secure platforms	Use metaverse technologies with strong encryption and privacy safeguards
Educate users about privacy	Provide training on best practices for safeguarding personal information within virtual environments.

## 4 CONCLUSIONS

The integration of the metaverse into higher education has the potential to revolutionise learning by fostering immersive, interactive, and personalised experiences that go beyond traditional methodologies. As this study highlights, the metaverse supports experiential learning, enhances collaboration, and provides risk-free environments for students to engage in real-world simulations. However, its adoption is not without challenges, which are primarily pedagogical, technical, social, and ethical in nature.

From the pedagogical dimension, two notable challenges are highlighted in the literature: the integration of metaverse technologies with existing curricula and the development of appropriate content. From a technical perspective, issues such as accessibility, costs, infrastructure, and interoperability must be addressed to ensure scalable and effective implementation. Social and ethical concerns, including data privacy, equity, and mental health implications, also demand careful consideration to prevent unintended consequences. Despite these challenges, the pedagogical benefits, such as increased engagement, interdisciplinary collaboration, and personalised learning, highlight the transformative potential of the metaverse in academia.



Future studies should explore effective methods for implementing the proposed strategies to integrate the metaverse into diverse curricula, with a focus on content development, interdisciplinary approaches, and best practices for enhancing student engagement.

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