



## IMMERSIVE LEARNING MEETS THEORY: MODELING EDUVERSE ADOPTION IN HIGHER EDUCATION

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## ABSTRACT

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Aim/Purpose	This study develops and empirically tests an integrated model to explain teachers' adoption of Eduverse (Metaverse education) technologies in higher education. Drawing from TAM, UTAUT, TPACK, Social Cognitive Theory (SCT), and Organizational Support Theory (OST), the study incorporates technological, pedagogical, individual, and institutional dimensions.
Background	Research on teachers' use of digital technologies has focused on m-learning, e-learning, AR/VR, LMS, and social media, but these insights may not fully apply to the Metaverse due to differences in context, pedagogy, and user factors. Thus, studying instructors' willingness to teach in Metaverse classrooms is a distinct and important research area.
Methodology	This quantitative study examined factors influencing Jordanian university teachers' adoption of Eduverse using a cross-sectional survey. Data were collected via an online questionnaire from 426 valid responses across five universities. Convenience sampling was applied, and sample adequacy was confirmed through G*Power analysis. Data were analyzed using PLS-SEM with SmartPLS 4.0, following a two-stage process: assessing measurement model reliability/validity and testing structural model relationships. This method was chosen for its suitability in handling complex, non-normal data within the M-TPACK framework.
Contribution	This study extends the TPACK framework into the Metaverse, introducing M-TPACK to capture the unique interplay of technology, pedagogy, and content in immersive learning. Drawing on SCT, it highlights the role of teacher self-efficacy, while OST emphasizes top management support and institutional facilitation, moderated by digital organizational culture. By integrating TAM, UTAUT, TPACK, SCT, and OST, the study proposes a multidimensional framework addressing individual, pedagogical, and institutional factors, identifying key success drivers for higher education Metaverse (Eduverse) adoption.
Findings	The results from a survey of 426 Jordanian university teachers indicate that top management support and facilitating conditions have a significant effect on M-TPACK, demonstrating top management's role and institutional readiness in enhancing metaverse-related teaching skills. M-TPACK positively impacts teachers' self-efficacy, perceived usefulness, and ease of use of Eduverse technologies, highlighting how integrated skills boost confidence and value. Self-efficacy significantly predicts both perceived usefulness and adoption intention, indicating that competence-building initiatives can increase adoption rates. Perceived usefulness and ease of use both directly affect teachers' intention to adopt Eduverse, confirming core assumptions of TAM. Additionally, digital organizational culture significantly moderates the effects of perceived usefulness and ease of use on adoption intention, highlighting the importance of innovation-friendly institutional norms.
Recommendations for Practitioners	The study highlights that strong top management commitment and supportive conditions are essential for developing MTPACK and integrating Metaverse (Eduverse) technologies in higher education. Universities should align leadership strategies with resource allocation, recognition programs, collaboration initiatives, and robust technical and pedagogical support systems. A phased, holistic approach combining infrastructure, training, peer mentoring, and discipline-specific resources can enhance faculty self-efficacy, ease of use, and perceived

usefulness of Eduverse. By balancing technical sophistication with usability and embedding evaluation frameworks, institutions can foster sustainable adoption of Metaverse-based teaching to improve teaching quality and student learning outcomes.

Recommendations for Researchers	This study develops a multi-theoretical framework to explain the adoption of Eduverse by higher education teachers. It introduces M-TPACK, an extension of the traditional TPACK model, tailored for immersive learning environments. Findings show that M-TPACK strongly predicts adoption, highlighting its greater importance in 3D virtual teaching than in conventional digital contexts. The study underscores M-TPACK as a key factor driving adoption in complex metaverse-based education.
Impact on Society	This study is one of the first to examine the adoption of Eduverse in the Middle East. It offers strategic insights on promoting immersive learning through leadership, training, and supportive cultures, while also laying the groundwork for future Metaverse research in higher education.
Future Research	This study provides valuable insights into Eduverse adoption in higher education, but it also has limitations. Its focus on Jordanian universities limits generalizability, and the cross-sectional design restricts temporal understanding. Future research should include cross-country comparisons, longitudinal tracking, and additional psychological and contextual factors. Mixed-method approaches combining quantitative and qualitative insights are also recommended.
Keywords	digital culture, metaverse, leadership, digital transformation, digital pedagogy, gamification

## INTRODUCTION

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The Metaverse represents the next stage in the evolution of the Internet (Mehta et al., 2025), comprising interconnected virtual environments (Wang & Lai, 2023) where users interact through digital avatars (Zhou et al., 2023) in immersive, shared spaces (Al-Adwan et al., 2023). In education, the Metaverse holds transformative potential, particularly through the use of Metaverse classrooms (Chen, 2024; Xie et al., 2025). The global shift to virtual learning, accelerated by recent crises, underscores digitalization as a key trend (Martín-Gutiérrez et al., 2017). By leveraging immersive technologies, educators can create experiential, mixed-reality learning environments (Beck, 2019; Mercer et al., 2019) that foster dynamic and engaging pedagogical experiences (Mehta et al., 2025). These classrooms simulate physical education settings (Al-Adwan, Alsoud, et al., 2024), provide instructors, students, and administrators with virtual identities (Almurtadha, 2025; Lam & Kiu, 2024), and seamlessly integrate virtual and real-world learning. This integration positions the Metaverse as a powerful tool to redefine academic engagement and collaboration (Nah et al., 2025).

Metaverse education (hereafter Eduverse) offers innovative experiences through social interaction, creative expression, immersive environments, and virtualization (Almurtadha, 2025; Buragohain et al., 2023; Souiet et al., 2024; Q. Zhang, 2023). The concept of the Metaverse classroom involves applying these elements to education, with platforms developed by companies like Roblox, Meta, and Zepeto aimed at enhancing learning experiences (Mehta et al., 2025). The Eduverse market is expected to reach US\$3.7 billion in 2025 and grow at a compound annual growth rate (CAGR) of 46.60% (Statista, 2024). By 2030, it is projected to reach a market volume of US\$24.7 billion. Although existing studies mainly focus on student adoption (Al-Kfairy et al., 2022; Mehta et al., 2025), it is equally important to examine the supply side, particularly professors' intentions to teach in Metaverse classrooms.

Research on teachers' adoption of digital technologies has predominantly examined m-learning (Aznar-Díaz et al., 2020), e-learning systems (Mashroofa et al., 2023), AR/VR (Czok et al., 2023), learning management systems (Lavidas et al., 2022), and social media (Alshalawi, 2022). The generalizability of these findings to broader Metaverse technology is limited by contextual variations in resources, content, pedagogy, support, domains, and user demographics (Abad-Segura et al., 2020). Consequently, exploring instructors' intentions and willingness to teach in Metaverse classrooms holds distinct research significance (Haleem et al., 2022).

Despite Eduverse's early-stage adoption in Jordan, the Ministry of Higher Education (2023) positions it as central to the country's strategic e-learning transformation. A recent report commissioned by Meta and Deloitte projects that the Metaverse could contribute up to \$1.7 billion to Jordan's GDP by 2035, highlighting its potential to transform key sectors such as education, gaming, wellness, and commerce (The Jordan Times, 2023). The report also notes a growing interest in Metaverse adoption among Jordanian Islamic bankers, further emphasizing the national significance of this digital evolution (Alshurafat et al., 2024). Understanding the experiences, challenges, and lessons learned during Eduverse implementation in Jordan can provide valuable insights for higher education stakeholders worldwide, particularly in developing countries across the Middle East and the Arab region. To date, most research in Jordan has focused on Eduverse adoption from the student perspective (Alkhwaldi, 2024), while factors influencing instructors' adoption remain underexplored. In response, this study, one of the first of its kind in Jordan, aims to identify the critical factors that shape university instructors' intentions to adopt Eduverse technology. By assessing faculty perspectives, the study gauges higher education readiness for this shift and directly supports national goals to drive educational innovation and enhance global competitiveness.

Accordingly, this study seeks to answer the main research question:

*What are the key individual, pedagogical, and institutional factors influencing university instructors' intentions to adopt Eduverse technology in Jordanian higher education?*

To address this question, the study aims to explore how individual perceptions, pedagogical readiness (M-TPACK), and institutional enablers shape adoption behavior. Furthermore, it examines the moderating role of digital organizational culture in strengthening or weakening these relationships.

This study advances Metaverse adoption research through three key contributions: theoretical, methodological, and contextual. First, it develops an integrated theoretical framework that synthesizes and extends established models, including the Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), Technological Pedagogical Content Knowledge (TPACK), Social Cognitive Theory (SCT), and Organizational Support Theory (OST), to provide a comprehensive explanation of Eduverse adoption. Unlike prior research that often examines these theories in isolation, this study bridges their complementary perspectives, capturing individual perceptions (perceived usefulness, perceived ease of use, self-efficacy), pedagogical readiness (M-TPACK), institutional enablers (top management support, facilitating conditions), and the moderating role of digital organizational culture. This multi-layered framework addresses gaps in existing models by simultaneously considering technological, human, pedagogical, and organizational dimensions, providing a more nuanced understanding of adoption drivers than any single theory can offer.

Second, this study makes a methodological contribution by adapting the TPACK framework specifically to the Metaverse context and introducing the validated M-TPACK construct. While previous research has applied TPACK broadly to educational technologies, this study customizes the framework to address the unique challenges of immersive Metaverse-based teaching, exploring how teachers integrate technology, pedagogy, and content knowledge within 3D virtual environments. Additionally, it empirically examines the moderating role of digital organizational culture on adoption intentions, demonstrating how institutional norms and values can either strengthen or weaken the rela-

tionships between key predictors, such as self-efficacy and perceived usefulness, and the resulting behavioral outcomes. These findings advance both the TPACK literature and organizational perspectives in educational technology research.

Third, this study addresses an important contextual gap by examining Metaverse adoption in Jordanian higher education, representing developing economies where resource constraints, cultural factors, and institutional readiness influence the integration of technology. As one of the first investigations of Eduverse adoption in the Middle East, it provides region-specific insights that enrich global discussions on emerging educational technologies. The findings highlight the need for adaptable adoption models that address cultural, infrastructural, and pedagogical factors, thereby contributing to both Metaverse research and its practical implementation. Moreover, the proposed framework guides future research and offers strategies for implementing immersive learning technologies in educational contexts.

The remainder of this paper begins with a literature review, which includes the theoretical foundation and hypothesis development, identification of research gaps, and establishment of the theoretical basis. The methodology section outlines the research design, instruments, sampling procedures, and ethical considerations. The results are presented clearly, followed by a discussion that interprets the findings and highlights the study's contributions. The research implications section, encompassing both theoretical and practical implications, extends the significance of the findings. Finally, dedicated sub-sections on limitations and future work provide practical recommendations for educators, policy-makers, and researchers.

## **THEORETICAL FRAMEWORK**

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This study integrates multiple theoretical models to comprehensively examine the adoption of Eduverse teaching by higher education teachers. While TAM and UTAUT are commonly used in educational technology research, their limitations require combining frameworks. TAM, introduced by Davis (1989), identifies Perceived Usefulness (PU) and Perceived Ease of Use (PEU) as key drivers of adoption intention, yet its narrow focus on technical factors overlooks broader organizational and pedagogical influences (Al-Adwan, Meet, et al., 2024; Z. Zhang et al., 2022). Similarly, UTAUT (Venkatesh et al., 2003) extends TAM by adding performance expectancy, effort expectancy, social influence, and facilitating conditions. Yet it neglects several individual factors, such as self-efficacy and specific pedagogical knowledge necessary to integrate educational technology into the curriculum (Al-Adwan et al., 2025).

This study further bridges these gaps by extending the TPACK framework (Mishra & Koehler, 2006) into the Metaverse context and introducing M-TPACK as a critical construct. TPACK has informed general educational technology adoption (Khong et al., 2023; Wangdi et al., 2023), yet it needs to be adapted to the Metaverse to cater to the distinct technology-pedagogy-content interplay needed in immersive learning environments. Hence, SCT (Bandura, 1986) is used within the study to consider Metaverse self-efficacy, as teachers' confidence in these tools is important to their decision on whether to adopt.

Moreover, the OST (Eisenberger et al., 1986) is imposed to accentuate the enabling roles of top management support and facilitating conditions that facilitate institutional support for the adoption. These relationships, however, are moderated by digital organizational culture, which either exacerbates or minimizes the impact of perceptions, support, and readiness. Innovation-friendly cultures boost the effect on adoption, while risk-averse ones diminish it.

Integrating TAM, UTAUT, TPACK, SCT, and OST, this study develops a multidimensional framework (Figure 1) that connects individual, pedagogical, and institutional dimensions. This integrated framework overcomes the limitations of single models by simultaneously addressing teacher percep-

tions, competencies, and institutional factors in the adoption of the higher education Metaverse. Incorporating digital organizational culture as a moderator enriches the framework by recognizing institutional influences on adoption. This integrated approach identifies critical success factors for Eduverse implementation.

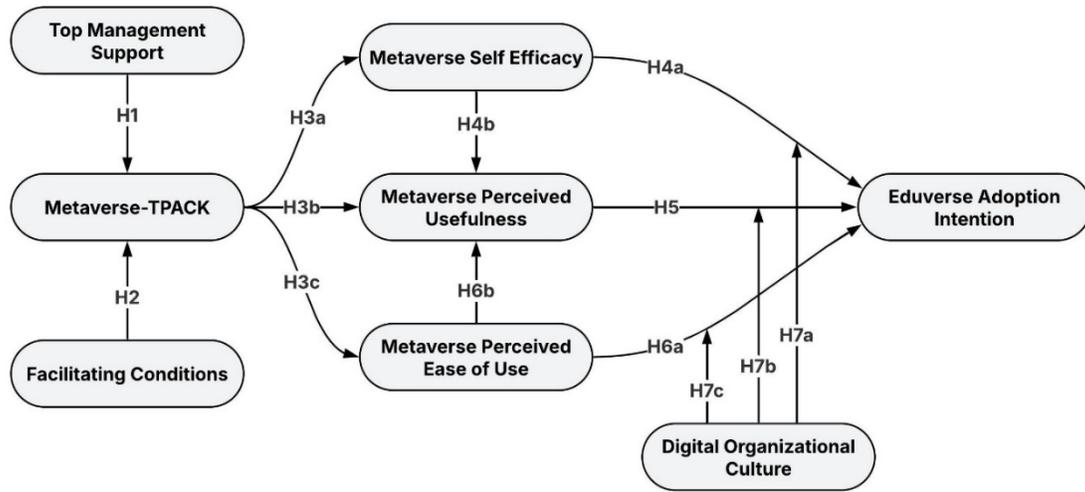


Figure 1. The research model

## LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

### *TOP MANAGEMENT SUPPORT*

Management support reflects leadership’s endorsement of technology integration in educational practices (Andić et al., 2022). Studies identify professional barriers as the foremost challenge in faculty digital technology adoption (Mercader & Gairin, 2020). This finding underscores the crucial need for enhanced professional development opportunities for teachers alongside increased institutional commitment through strategic planning initiatives (Al-Adwan, Meet et al., 2024; Dong et al., 2020; Kulaksız & Karaca, 2023; Maipita et al., 2023). In this study, top management support represents teachers’ perceptions of institutional leadership’s role in technology adoption. Support is provided through motivation, advanced technological tools, training, and access to subject matter experts from administrators, decision-makers, and their stakeholders. Strong institutional support is necessary for effective Metaverse integration to overcome implementation barriers and meet pedagogical content needs (Onu et al., 2024).

**H1:** Top management support positively influences M-TPACK.

### *FACILITATING CONDITIONS*

Facilitating conditions represent an organization’s environmental readiness to support technology adoption, encompassing the infrastructure and resources that enable task completion (Teo & Noyes, 2014). Facilitating conditions significantly impact teachers’ TPACK development by providing the necessary support and resources. This includes access to technology, professional development opportunities, and a supportive school culture that encourages experimentation and collaboration (Al-Adwan et al., 2025; Anthony et al., 2023; Cabellos et al., 2024). The role of facilitating conditions in the development of TPACK among preservice teachers with virtual reality is indicated in the recent research (Al-Adwan et al., 2025; Thohir et al., 2023; Tram, 2025).

However, several significant obstacles to implementing the Metaverse in education have also been identified, including insufficient educator training resources, inadequate technological support, and a lack of access to required digital tools and reliable connectivity (Onu et al., 2024). Effective integration of the Metaverse into education requires robust facilitating conditions, including specialized professional development to equip teachers with immersive pedagogical strategies (Mgeladze et al., 2024), advanced infrastructure (e.g., VR/AR tools, reliable connectivity) (Kulaksız & Karaca, 2023), and comprehensive technical and administrative support to navigate challenges. Crucially, fostering a culture that values innovation and student-centered approaches, leveraging the Metaverse's interactivity to boost engagement and refine teaching practices (TPACK), motivates teachers to embrace these technologies (Kulaksız & Karaca, 2023). All these conditions strengthen adaptability, increase learning experiences, and give teachers the power to embrace the Metaverse's potential for education fully.

**H2:** Facilitating conditions positively influence M-TPACK.

### ***METAVERSE-TPACK (M-TPACK)***

The technological pedagogical content knowledge (TPACK) framework (Mishra & Koehler, 2006) serves as a foundational model for integrating technology into classroom instruction. It highlights the interplay between three core knowledge domains: pedagogical knowledge (PK), content knowledge (CK), and technological knowledge (TK), as well as their intersections, including technological pedagogical knowledge (TPK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPACK). This model offers teachers a structured approach to effectively integrate technology into their teaching practices (Al-Adwan, Meet, et al., 2024; Habibi et al., 2025). The TPACK model highlights the challenges of teaching with technology. Successful integration depends on both expertise and knowing how to pair it with pedagogy and content to bring about important learning paths (Al-Adwan et al., 2025).

TPACK has been widely adopted and recognized as a method to help teachers integrate technology into education (Luik et al., 2024). Comprehensively, it provides a rich illustration of the intricate web of connections among teachers, students, technological tools, learning materials, and instructional techniques (Bai et al., 2024). Research suggests that teachers who possess well-developed TPACK are more confident and purposeful in their use of digital tools for teaching (Liu et al., 2025).

Evidence exists to support a relationship between TPACK and the self-efficacy of teachers. Teachers who effectively apply TPACK are more likely to view technology as useful and easy to use (Bai et al., 2024; Joo et al., 2018). This underscores its critical role in fostering technology-based learning environments. At its core, TK encompasses the ability to utilize digital tools, including computers, the internet, tablets, and educational software, while also adapting these technologies to enhance learning environments (Koehler et al., 2017). TCK pertains to understanding how technology facilitates content delivery, whereas TPK focuses on the affordances and constraints of technology in different pedagogical contexts. By integrating these knowledge domains into TPACK, teachers can be enabled to design, implement, and evaluate effective digital learning experiences. It emphasizes its importance as a directive framework for present-day education.

The M-TPACK framework is an extension of the traditional TPACK model that includes Metaverse technologies in educational practices. As virtual and augmented reality gain prominence, teachers must develop the competencies to integrate these immersive technologies into teaching and learning effectively. Building upon three core knowledge domains (PK, CK, and TK), M-TPACK also accounts for their intersections: M-TPK, M-TCK, and M-TPACK (see Table 1). Specifically, this enhanced model explicitly takes into account the unique affordance of the Metaverse: 3D virtual spaces, digital avatars, interactive simulations, and AI-driven adaptive learning (Mehta et al., 2025).

M-TPACK enhances teacher self-efficacy by equipping teachers with the necessary technological, pedagogical, and content knowledge to confidently integrate Metaverse tools into teaching (Tram,

2025). Mastery of Metaverse technologies (M-TK) and their instructional applications (M-TPACK) fosters confidence in delivering immersive and interactive lessons. Teacher competence in immersive technologies (VR/AR/AI) increases willingness to innovate, enhancing digital classroom effectiveness (Al-Marroof et al., 2024).

**Table 1. M-TPACK components**

<b>Metaverse-TPACK component</b>	<b>Description</b>	<b>Examples</b>
Metaverse-Technological Knowledge (M-TK)	Understanding and utilizing Metaverse tools such as VR, AR, AI-driven avatars, and blockchain-based learning platforms (Dreamson & Park, 2023; Peng et al., 2024).	VR classrooms, AR-enhanced textbooks, AI tutors, blockchain-based certification (Murala, 2024; Polychronaki et al., 2024).
Metaverse-Content Knowledge (M-CK)	Applying subject-specific content effectively in immersive environments through simulations and gamification (Almurtadha, 2025; W. Yang et al., 2024).	Virtual chemistry labs, interactive history reenactments, 3D anatomical models (Almurtadha, 2025; Jamshaid, 2025; Souiet et al., 2024).
Metaverse-Pedagogical Knowledge (M-PK)	Implementing student-centered and experiential learning strategies in the Metaverse (Almurtadha, 2025; Damaševičius & Sidekersniene, 2023).	Role-playing exercises, virtual teamwork projects, real-world scenario simulations (Lau et al., 2025; Yeganeh et al., 2025).
Metaverse-Technological Pedagogical Knowledge (M-TPK)	Enhancing instructional strategies using Metaverse technologies to foster engagement and personalized learning (Bazargani et al., 2025; Yeganeh et al., 2025).	AI-driven adaptive learning paths, VR storytelling for language acquisition, interactive problem-solving tasks (Almurtadha, 2025).
Metaverse-Technological Content Knowledge (M-TCK)	Utilizing Metaverse tools to enhance content understanding and application in specific subjects (Wong et al., 2024).	AR overlays for medical training, VR-based engineering simulations, blockchain credential tracking (Popov et al., 2024; Uddin et al., 2024).
Metaverse-Technological Pedagogical Content Knowledge (M-TPACK)	Integrating all components to create holistic, immersive, and interactive learning experiences (Almurtadha, 2025; Villegas-Ch et al., 2024).	Fully immersive Metaverse classrooms with adaptive AI tutors, gamified lesson plans, student-driven exploration of virtual environments (Almurtadha, 2025; Priya Iyer & Vairamani, 2024; Yeganeh et al., 2025).

Several studies indicate that TPACK significantly influences teachers' PEU of educational technologies, including VR and AR (Jang et al., 2021; Ko & Shin, 2023). Teachers' TPACK makes it possible for the integration of Metaverse technologies in teaching (Jafari, 2023). Higher TPACK-proficient teachers experience ease of use when creating more effective Metaverse learning experiences (Ueno et al., 2024). A solid grounding in M-TPACK represents a major step in easing teachers' concerns about the difficulties of Metaverse tools, which are then more understandable and practicable to teachers (Al-Marroof et al., 2024). The knowledge of Metaverse platforms (M-TK, M-TCK) and their educational integration (M-TPK) into the courses developed by instructors makes the development

of such courses easy with less effort to overcome technical obstacles. Teachers who perceive immersive technologies as easy to implement show higher adoption rates, enabling seamless integration and improved learning outcomes (Thohir et al., 2023).

Teachers' TPACK levels directly predict their acceptance and perceived usefulness of Metaverse/AR-VR tools, with higher TPACK correlating to greater confidence in both usability and instructional value (Jang et al., 2021; Ko & Shin, 2023; Thohir et al., 2023; J. Yang et al., 2021). Within the TPACK framework, Technological Knowledge (TK) emerges as the most critical component, surpassing Pedagogical (PK) and Content Knowledge (CK) in shaping teachers' perceptions of digital tools' utility (J. Yang et al., 2021). Enhanced TPACK equips teachers to integrate technology more effectively, fostering both practical implementation and a stronger belief in its educational impact, especially in immersive learning environments like AR/VR-based instruction (Jang et al., 2021; Ko & Shin, 2023). Teachers with high M-TPACK proficiency recognize the tangible benefits of Metaverse tools in education, reinforcing their perceived usefulness (Tram, 2025). By leveraging Metaverse-based content delivery (M-CK, M-TCK) and interactive teaching strategies (M-PK, M-TPK), teachers see improvements in student engagement, personalized learning, and knowledge retention. Observing immersive learning's positive impact motivates teachers to adopt and advocate for Eduverse, accelerating broader educational acceptance.

**H3a:** M-TPACK positively influences Metaverse self-efficacy.

**H3b:** M-TPACK positively influences Metaverse perceived usefulness.

**H3c:** M-TPACK positively influences Metaverse perceived ease of use.

### ***METAVVERSE SELF-EFFICACY***

Teacher self-efficacy drives technology adoption, mediated by their emotional responses and attitudes toward digital tools (Ding & Hong, 2024; Kamran et al., 2024). Teacher self-efficacy fosters both technology integration and innovative adoption of emerging tools like Metaverse platforms (Alshuhumi et al., 2025). Metaverse self-efficacy reflects teachers' perceived ability to effectively integrate relevant technologies (e.g., VR, AR, AI) into their pedagogical practice (A. H. D. Nguyen et al., 2024). This concept encompasses teachers' beliefs in their capacity to design, organize, and implement immersive learning experiences within Metaverse environments to achieve desired instructional outcomes (Al-Adwan, Meet, et al., 2024; Tram, 2025). Metaverse self-efficacy encompasses teachers' confidence in using these technologies to boost engagement, foster interactive learning, and achieve educational goals, going beyond mere technical skills. High self-efficacy Metaverse teachers are likely to embrace new, immersive educational approaches, including gamified learning or virtual simulations, and demonstrate more openness to using new technologies to enhance their teaching (Alibakhshi et al., 2020; Bilous et al., 2025; Zhu et al., 2025). Moreover, high self-efficacy is linked to higher intentions to incorporate Eduverse into the classroom, as teachers with great confidence in their skills are more likely to explore and create within virtual learning environments (Joo et al., 2018; Menabò et al., 2021). Additionally, self-efficacy has a positive influence on perceived usefulness (PU) (Al-Adwan et al., 2025; Usman et al., 2020); teachers who are confident in their technological abilities are more likely to view digital tools as valuable for teaching and learning.

**H4a:** Metaverse self-efficacy positively influences Eduverse adoption intention.

**H4b:** Metaverse self-efficacy positively influences Metaverse perceived usefulness.

### ***METAVVERSE EASE OF USE AND USEFULNESS PERCEPTIONS***

Both perceived ease of use (PEU) and perceived usefulness (PU) play a critical role in the adoption of the Metaverse in educational contexts, as these factors significantly influence users' intentions to integrate and utilize such immersive technologies for learning purposes (Abu-Rumman & Qawasmeh, 2022; Bhat et al., 2025). PEU measures teachers' assessment of Metaverse teaching tech-

nology as intuitive, user-friendly, and easy to operate (Lee et al., 2022; Ma et al., 2025). When teachers perceive technology as easy to use, they are more likely to recognize its pedagogical value for enhancing instruction (Al-Adwan, Meet, et al., 2024; Riady et al., 2025). Research has shown that teachers who find Metaverse easy to use tend to develop positive attitudes toward incorporating it into their teaching (Ali et al., 2025; Mehta et al., 2025). Teachers' positive attitude toward Metaverse teaching strongly influenced their intention to adopt it. Similarly, PU, defined as teachers' belief that Metaverse improves teaching effectiveness and student outcomes (Akour et al., 2022; Mukred et al., 2025), also played a key role. Teachers who view the Metaverse as beneficial are more likely to form a favorable attitude towards using it. Studies indicate that PU plays a significant role in shaping teachers' attitudes towards adopting innovative technologies in the classroom (Al-Adwan, Meet, et al., 2024b; Chua & Yu, 2024), with a positive attitude being closely tied to their intention to integrate the Metaverse into their teaching. Additionally, PEU significantly predicts PU, a relationship mediated by external variables (Davis, 1989) and consistently validated in educational technology studies (Al-Adwan, Meet, et al., 2024; Al-Adwan et al., 2025).

**H5:** Metaverse perceived usefulness positively influences Eduverse adoption intention.

**H6a:** Metaverse perceived ease of use positively influences Eduverse adoption intention.

**H6b:** Metaverse perceived ease of use *positively influences Metaverse perceived usefulness*.

### ***DIGITAL ORGANIZATIONAL CULTURE***

Amid accelerating digitalization and increasing regulations, organizations must cultivate adaptive cultures to enable successful transformation (Önday, 2016). A culture aligned with digital change ensures initiatives are implemented effectively and sustainably. Schein (2010) contends that technology and globalization fundamentally reshape organizations by transforming work processes and dissolving traditional boundaries. Numerous researchers have highlighted organizational culture as a critical factor influencing the success of digital transformation efforts.

Mohamed Hashim et al. (2022) view culture as important in setting digital transformation strategies in the case of higher education institutions (HEIs). The authors introduce the concept of a digital culture and acknowledge that a transition to this culture still poses a big challenge. In fact, Martínez-Caro et al. (2020) argue that digital organisational culture is one of the key facilitators of the successful digital technology implementation in organisational settings. Sustainable digital transformation and organizational change need to be supported (Abdallah et al., 2022). This necessitates fostering an adaptive and agile organizational culture. While organisational culture may not directly determine organizational effectiveness, it plays a crucial role in shaping employee behaviours and responses to change. In many cases, organizations have failed to realize the expected benefits of digital transformation due to conflicts with entrenched cultural norms. Thus, cultivating a digital organizational culture aligned with transformation principles is essential for sustainable success (Martínez-Caro et al., 2020).

Digital organizational culture critically shapes teachers' technology adoption intentions by mediating policy perceptions (Huang & Teo, 2020). Supportive cultures enhance policy relevance perceptions, fostering positive tech integration attitudes and greater tool adoption willingness. Digital organizational culture serves as a moderating force that shapes the interplay between technology adoption drivers and behavioral intentions (Huang & Teo, 2020; Zheng et al., 2024). In Metaverse-adopting institutions, organizational culture directly shapes teachers' perceptions of utility and usability, key determinants of engagement willingness. Evidence suggests that a strong organizational learning culture increases acceptance of emerging media technologies (Shen & Yang, 2021), a stream that could continue as Metaverse integration begins as well. Therefore, a favorable culture can reinforce featured benefits and decrease adoption barriers for fostering behavioral intentions towards innovative tools.

PEU significantly predicts technology adoption intentions, though digital organizational culture moderates this relationship, either strengthening or weakening PEU's influence on teachers' adoption decisions (Huang & Teo, 2020; Sun & Yan, 2025). While PEU's direct effect on behavioral intention may occasionally lack statistical significance, it remains pivotal when mediated by variables such as perceived usefulness and organizational support, underscoring its indirect yet critical role in shaping adoption outcomes (Al-Adwan et al., 2023; Sun & Yan, 2025). In the context of Eduverse adoption, digital organizational culture plays a critical moderating role in shaping the relationship between perceived ease of use (PEU) and teachers' behavioral intention to adopt Metaverse technologies in education. In creative and innovation-driven HEIs, where experimentation is encouraged, sufficient training is provided, and resistance to change is minimized, teachers are more likely to translate their perceptions of Metaverse usability into actual adoption behavior. Conversely, in rigid or risk-averse organizational environments, where institutional barriers exist and support is limited, the positive influence of PEU may be weakened. In such settings, even if teachers perceive the Eduverse as easy to use, organizational constraints can hinder their intention to implement it in practice. Therefore, the cultural context within educational institutions is a pivotal factor that can either enable or inhibit the conversion of usability perceptions into adoption intentions among teachers.

Digital organizational culture improves the perceived usefulness (PU) of technology by cultivating an environment that prioritizes innovation and effective technological integration (Tabibi et al., 2015, 2018). This culture also moderates the relationship between PU and behavioral intention, amplifying it through supportive conditions that encourage adoption (Huang & Teo, 2020; Mahara et al., 2021; Tseng, 2017). A culture valuing collaboration, learning, and adaptability can increase teachers' receptiveness to Metaverse technologies, linking perceived benefits to stronger adoption intentions (R. Zhang & Wang, 2024). In an innovation-driven digital organizational culture, teachers are more likely to recognize and embrace the benefits of the Eduverse for teaching. Such a culture encourages digital transformation by means of resources, training, and incentives supporting the apparent value of Eduverse. When PU is high in a culture that values technological advancement, teachers are more motivated to integrate the Metaverse into their pedagogical approaches. However, in traditional or rigid digital organizational cultures that resist change, even if teachers perceive the Metaverse as useful, institutional constraints, lack of administrative support, and resistance to digital adoption may weaken their behavioral intention to use it.

Digital organizational culture acts as a pivotal moderator in shaping teacher self-efficacy and their professional behaviors (Alshuhumi et al., 2025; Choong et al., 2024; Nordin et al., 2017). A positive organizational climate not only strengthens teachers' confidence in their abilities but also fosters innovative practices, including the integration of emerging technologies like the Metaverse (Alshuhumi et al., 2025). Cultural values and collective efficacy further moderate the interplay between leadership behaviors and teacher self-efficacy, amplifying or dampening teachers' willingness to adopt new tools (Kaya & Koçyigit, 2023; Luo et al., 2024). For example, a teacher's adoption intention toward Metaverse technology depends on their perceived educational value of Metaverse technology and their perceived ability to use it. Organizational support plays a major role in boosting the successful implementation of innovative educational technologies as it significantly enhances teacher self-efficacy (Aideed et al., 2025). Teachers with high self-efficacy will feel more empowered to experiment with Metaverse-based teaching in an environment that encourages collaboration, professional development, and continuous learning. They are more likely to engage in peer learning, seek out training, and take risks in implementing immersive learning experiences. Conversely, unsupportive digital cultures, where tools are deprioritized or failure punished, deter even high-efficacy teachers from Metaverse integration due to fear, lack of support, or resource gaps. Hence, digital organizational culture positively moderates the relationship between:

**H7a:** Digital organizational culture positively moderates the relationship between Metaverse self-efficacy and Eduverse adoption intention.

**H7b:** Digital organizational culture positively moderates the relationship between Metaverse perceived usefulness and Eduverse adoption intention.

**H7c:** Digital organizational culture positively moderates the relationship between Metaverse perceived ease of use and Eduverse adoption intention.

## RESEARCH METHODOLOGY

This quantitative study investigated the main factors influencing higher education teachers' adoption of Eduverse in Jordanian universities. A cross-sectional survey design was utilized to collect data from teachers across five Jordanian universities (three public and two private institutions). Due to the unavailability of a comprehensive sampling frame, convenience sampling was employed to recruit participants. This non-probability sampling approach allowed for efficient and timely recruitment of participants who were accessible and willing to respond to the survey, ensuring adequate representation from both public and private institutions (Golzar et al., 2022). Data collection commenced in January 2025 and spanned two months, using an online questionnaire developed with Google Forms and distributed to teachers via email and various social media platforms. A total of 437 responses were received, of which 11 were eliminated due to excessive missing data (more than 85% incomplete), resulting in 426 valid responses for analysis (see Table 2). The minimum required sample size was calculated using G\*Power software, which indicated that 98 participants would be sufficient based on a statistical power of 0.80, an alpha level of 0.05, an effect size of 0.15, and six predictors. With the actual sample size of 426 substantially exceeding this minimum threshold, sample size adequacy was confidently established for this study.

**Table 2. The demographic characteristics of the study respondents**

Category	Groups	Percentage (%)	Frequency (n = 426)
<b>Gender</b>	Male	44%	187
	Female	56%	239
<b>University type</b>	Public	63%	268
	Private	37%	158
<b>Teaching experience</b>	1-5 years	34%	146
	6-10 years	42%	178
	> 10 years	24%	102
<b>Specialization</b>	Arts	15%	64
	Computer Sciences	21%	89
	Engineering	16%	68
	Business	23%	98
	Medical-related	19%	81
	Others	6%	26
<b>Educational level</b>	PhD	69%	294
	Master's	31%	132
<b>Educational technology experience</b>	1-3 years	39%	166
	4-7 years	33%	141
	> 7 years	28%	119

All questionnaire items were adapted from prior research and customized for the Metaverse-based teaching context in higher education (see Appendix). All items were assessed using a 5-point Likert scale, with response options ranging from 1 (strongly disagree) to 5 (strongly agree). To ensure content validity, a panel of three experts (professors specializing in information systems and educational technology) evaluated all items. Based on their assessment, minor adjustments were made to improve

clarity and relevance for the target population. A pilot test ( $n=37$ ) confirmed instrument reliability, with all scales exceeding the 0.7 Cronbach's alpha threshold for internal consistency. To enhance the validity and reliability of the responses, the questionnaire items were randomized rather than grouped by construct, minimizing potential response biases such as pattern answering or social desirability effects.

The study followed the highest ethical standards, with voluntary participation, informed consent, and assurances of confidentiality and anonymity. No personal or sensitive data was collected or disclosed. As the research was survey-based and involved no clinical or experimental procedures with humans or animals, formal ethical approval was not required under institutional guidelines. Nevertheless, it is important to note that the design complied with the ethical standards at Al-Ahliyya Amman University, Jordan. Ethical approval reference: AAU-BUS-2024-Desmber-ETHICS-427.

Mardia's test for multivariate normality confirmed that the data exhibited significant non-normality, with multivariate skewness (20.25) and kurtosis (173.06) values exceeding common cutoffs (Enomoto et al., 2020). Given these conditions, Partial Least Squares–Structural Equation Modeling (PLS-SEM) with SmartPLS 4.0 software was selected as the optimal analytical approach. PLS-SEM is suitable for research involving complex models with multiple latent constructs and indicators (Hair, Hult, Ringle, Sarstedt, et al., 2021). It is prediction-oriented, robust to smaller or non-normally distributed samples, and can handle both reflective and formative constructs. These features make PLS-SEM a flexible and powerful tool for testing and validating theoretical models while maximizing the explained variance of dependent variables. The analysis followed a comprehensive two-stage procedure: (1) Measurement Model Assessment, which evaluated construct reliability and validity through tests of indicator reliability, internal consistency reliability, convergent validity, and discriminant validity; and (2) Structural Model Assessment, which examined the hypothesized relationships between constructs by analyzing path coefficients, significance levels, coefficient of determination ( $R^2$ ), effect sizes ( $f^2$ ), and predictive relevance ( $Q^2$ ). PLS-SEM was ideal for this study because it handles complex models with multiple relationships and is robust to non-normal data, making it suitable for exploring the M-TPACK framework (Hair, Hult, Ringle, & Sarstedt, 2021).

## RESULTS

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### *PRELIMINARY ANALYSIS*

The possibility of common method bias (CMB) due to the use of one survey tool to measure all variables deserves critical attention, as reported by MacKenzie et al. (2011). Harman's single-factor test was used to assess this risk (Fuller et al., 2016). The subsequent analysis showed that CMB was not a serious threat, as the former explained just 37.2% of the overall variance, compared to the traditional 50%.

### *MEASUREMENT MODEL*

We examined the reflective measurement model (Hair et al., 2019) for construct validity (i.e., indicator reliability and convergent/discriminant validity). Initially, we analyzed all indicator loadings. A loading of 0.708 or greater was acceptable. As shown in Table 3, all indicators exceeded this threshold, indicating acceptable item reliability. To assess internal consistency, two measures were used: Cronbach's Alpha ( $\alpha$ ) and Composite Reliability (CR). Both values should be at least 0.7 and not exceed 0.95. The results confirm that all constructs fall within this range. This indicates strong internal consistency across the constructs. Furthermore, we examined convergent validity using two methods. First, we inspected each construct's Average Variance Extracted (AVE). All AVE values exceeded the 0.50 threshold, confirming that constructs explain over 50% of their indicators' variance. Second, we analyzed cross-loadings (Appendix). These findings confirmed that indicators load strongly on their assigned constructs. Both methods demonstrate convergent validity.

**Table 3. Measurement model assessment**

<b>Construct</b>	<b>Item</b>	<b>Loading</b>	<b><math>\alpha</math></b>	<b>CR</b>	<b>AVE</b>
<b>Digital organizational culture</b>	CUL_1	0.832	0.864	0.908	0.711
	CUL_2	0.849			
	CUL_3	0.859			
	CUL_4	0.832			
<b>Eduverse adoption intention</b>	INT_1	0.826	0.774	0.869	0.688
	INT_2	0.824			
	INT_3	0.840			
<b>Perceived ease of use</b>	PEU_1	0.890	0.865	0.908	0.712
	PEU_2	0.801			
	PEU_3	0.865			
	PEU_4	0.815			
<b>Facilitating conditions</b>	FC_1	0.824	0.779	0.871	0.693
	FC_2	0.820			
	FC_3	0.853			
<b>Metaverse self-efficacy</b>	SEE_1	0.767	0.779	0.858	0.602
	SEE_2	0.793			
	SEE_3	0.778			
	SEE_4	0.764			
<b>Top management support</b>	TOP_1	0.890	0.822	0.894	0.738
	TOP_2	0.871			
	TOP_3	0.814			
<b>Metaverse-TPACK</b>	TPACK_1	0.767	0.920	0.934	0.610
	TPACK_2	0.748			
	TPACK_3	0.775			
	TPACK_4	0.839			
	TPACK_5	0.807			
	TPACK_6	0.766			
	TPACK_7	0.781			
	TPACK_8	0.791			
	TPACK_9	0.750			
<b>Perceived usefulness</b>	PU_1	0.774	0.860	0.905	0.705
	PU_2	0.844			
	PU_3	0.848			
	PU_4	0.890			

The analysis then assessed discriminant validity to determine whether the constructs in the model are distinct from one another (Fornell & Larcker, 1981). Two methods were used: (1) the Fornell-Larcker criterion, and (2) the Heterotrait-Monotrait (HTMT) ratio of correlations. For the Fornell-Larcker criterion, the  $\sqrt{\text{AVE}}$  was calculated for each construct. Discriminant validity is confirmed when the  $\sqrt{\text{AVE}}$  value for each construct (shown in bold on the diagonal) is greater than the correlations with other constructs (values below the diagonal). As shown in Table 4, this condition is met for all reflective constructs, indicating that the Fornell-Larcker criterion is satisfied.

We also used the HTMT ratio to evaluate discriminant validity. The HTMT ratio compares between-construct correlations to within-construct correlations. An HTMT value below 0.85 indicates adequate discriminant validity (Henseler et al., 2015). All HTMT ratios (Table 4, above diagonal) fell below the threshold, confirming discriminant validity alongside Fornell-Larcker results.

**Table 4. Discriminant validity**

Construct	1	2	3	4	5	6	7	8
Digital organizational culture	<b>0.843</b>	0.846	0.530	0.286	0.502	0.291	0.353	0.532
Eduverse adoption intention	0.692	<b>0.830</b>	0.582	0.321	0.695	0.340	0.447	0.619
Perceived ease of use	0.460	0.478	<b>0.844</b>	0.516	0.525	0.453	0.512	0.643
Facilitating conditions	0.236	0.250	0.424	<b>0.832</b>	0.409	0.656	0.567	0.518
Metaverse self-efficacy	0.412	0.540	0.431	0.319	<b>0.776</b>	0.483	0.612	0.628
Top management support	0.246	0.273	0.382	0.527	0.388	<b>0.859</b>	0.624	0.598
Metaverse-TPACK	0.315	0.378	0.459	0.481	0.519	0.544	<b>0.781</b>	0.643
Perceived usefulness	0.460	0.506	0.558	0.423	0.516	0.507	0.573	<b>0.840</b>

### Structural model

Before analyzing the structural model, we assessed multicollinearity to prevent distorted regression results from high correlations among predictors (Meloun et al., 2002). The “Variance Inflation Factor” (VIF) was used to assess this (Hair et al., 2019). A VIF value above 3 indicates potential multicollinearity. However, as shown in Table 5, all independent variables had VIF values below this threshold, confirming that multi-collinearity is not an issue in our model.

We used two main measures to assess the structural model: the path coefficients ( $\beta$ ) and the coefficient of determination ( $R^2$ ) (Hair et al., 2019). To test significance, we applied a bootstrapping technique with 10,000 subsamples. T-values greater than 1.96 and P-values less than 0.05 (two-tailed) indicated statistical significance (Hair, Hult, Ringle, Sarstedt, et al., 2021). The results, shown in Table 5, indicate that twelve out of the thirteen proposed hypotheses were supported.

**Table 5. Hypotheses testing**

Hypotheses	Path	$\beta$	Mean	STDEV	CI	T statistics	P values	VIF	$f^2$
H1	TOP → TPACK	0.403	0.403	0.043	0.318, 0.484	9.417	0.000	1.385	0.180
H2	FC → TPACK	0.268	0.271	0.045	0.183, 0.357	6.032	0.000	1.385	0.080
H3a	TPACK → SEE	0.519	0.521	0.034	0.451, 0.584	15.136	0.000	1.000	0.368
H3b	TPACK → PU	0.314	0.313	0.042	0.231, 0.394	7.423	0.000	1.508	0.123
H3c	TPACK → PEU	0.459	0.459	0.039	0.380, 0.533	11.701	0.000	1.000	0.266
H4a	SEE → INT	0.210	0.210	0.039	0.134, 0.284	5.383	0.000	1.586	0.069
H4b	SEE → PU	0.215	0.217	0.044	0.133, 0.305	4.840	0.000	1.463	0.060
H5	PU → INT	0.141	0.145	0.044	0.060, 0.231	3.223	0.001	1.818	0.027
H6a	PEU → INT	0.121	0.120	0.042	0.037, 0.200	2.915	0.004	1.745	0.021
H6b	PEU → PU	0.321	0.321	0.042	0.238, 0.403	7.601	0.000	1.354	0.144
H7a	CUL x SEE → INT	0.030	0.032	0.038	-0.107, 0.042	0.803	0.422	-	-
H7b	CUL x PU → INT	0.089	0.091	0.041	0.009, 0.175	2.157	0.031	-	-
H7c	CUL x PEU → INT	0.139	0.137	0.041	0.054, 0.215	3.378	0.001	-	-

**Note 1.** TOP: Top Management Support, FC: Facilitating Conditions, SEE: Metaverse Self-efficacy, PU: Perceived Usefulness, PEU: Perceived Ease of Use, INT: Eduverse Adoption Intention, CUL: Digital Organizational Culture, TPACK: Metaverse-TPACK.

**Note 2.** CI: Confidence Intervals

Specifically, facilitating conditions ( $\beta = 0.268$ ) and top management support ( $\beta = 0.403$ ) both had a significant positive influence on teachers' intention to adopt Eduverse. In addition, Metaverse-TPACK had a significant positive effect on Metaverse Self-Efficacy, Metaverse Perceived ease of use, and Metaverse perceived usefulness (see Table 5). Moreover, both Metaverse perceived ease of use ( $\beta = 0.321$ ) and Metaverse self-efficacy ( $\beta = 0.215$ ) positively influenced Metaverse perceived usefulness. Finally, Metaverse self-efficacy ( $\beta = 0.210$ ), Metaverse perceived ease of use ( $\beta = 0.121$ ), and Metaverse perceived usefulness ( $\beta = 0.141$ ) all significantly and positively affected teachers' intention to adopt Eduverse. Finally, digital organizational culture positively moderated the relationships between Metaverse perceived ease of Use ( $\beta = 0.139$ ) and Metaverse perceived usefulness ( $\beta = 0.089$ ) with teachers' intention to adopt Eduverse. This indicates that a supportive digital culture strengthens the impact of these perceptions on adoption. However, it did not moderate the link between Metaverse self-efficacy and adoption intention ( $\beta = 0.030$ ), suggesting that self-efficacy may influence adoption independently of organizational culture.

We assessed model quality using the coefficient of determination ( $R^2$ ), which measures the variance explained in each dependent latent variable (Hair, Hult, Ringle, & Sarstedt, 2021). The model explained 60.1% ( $R^2 = 0.601$ ) of the variance in teachers' Eduverse adoption intention (see Table 6). This substantial result (Chin, 1998) confirms that the model effectively explains variations in adoption intention. Additionally, facilitating conditions and top management support explained 34.8% of the variance in Metaverse-TPACK ( $R^2 = 0.348$ ). Similarly, Metaverse perceived ease of use and Metaverse self-efficacy accounted for 47% of the variance in Metaverse perceived usefulness ( $R^2 = 0.470$ ). In addition, Table 6 presents the effect size ( $f^2$ ) for each independent construct. Cohen (1988) classifies  $f^2$  effect sizes as small (0.02), medium (0.15), and large (0.35), indicating each predictor's relative contribution to explained variance.

**Table 6. Predictive power**

Construct	R <sup>2</sup>	Q <sup>2</sup> predict	Item	Q <sup>2</sup> predict	PLS-SEM_RMSE	LM_RMSE	PLS-SEM_RMSE < LM_RMSE
<b>Eduverse adoption intention</b>	0.601	0.462	INT_1	0.311	1.096	1.098	Yes
			INT_2	0.301	1.042	1.048	Yes
			INT_3	0.341	1.008	1.009	Yes
<b>Perceived ease of use</b>	0.210	0.169	PEU_1	0.125	1.102	1.177	Yes
			PEU_2	0.110	1.210	1.160	No
			PEU_3	0.123	1.075	1.139	Yes
			PEU_4	0.126	1.116	1.171	Yes
<b>Metaverse self-efficacy</b>	0.269	0.154	SEE_1	0.071	1.154	1.179	Yes
			SEE_2	0.095	1.158	1.178	Yes
			SEE_3	0.103	1.163	1.140	No
			SEE_4	0.101	1.079	1.108	Yes
<b>Metaverse-TPACK</b>	0.348	0.341	TPACK_1	0.227	1.101	1.106	Yes
			TPACK_2	0.178	1.081	1.093	Yes
			TPACK_3	0.193	1.115	1.124	Yes
			TPACK_4	0.229	1.081	1.073	No
			TPACK_5	0.220	1.050	1.051	Yes
			TPACK_6	0.212	1.107	1.117	Yes
			TPACK_7	0.234	1.070	1.084	Yes
			TPACK_8	0.198	1.097	1.103	Yes
<b>Perceived usefulness</b>	0.470	0.247	PU_1	0.140	1.098	1.127	Yes
			PU_2	0.180	1.012	1.070	Yes
			PU_3	0.157	1.007	1.076	Yes
			PU_4	0.217	1.049	0.970	No

Finally, we assessed predictive power using PLS-Predict (Shmueli et al., 2019). The PLS model showed generally lower “root mean squared errors” RMSE values than “linear regression” (LM) across all dependent variables (Table 6), confirming superior predictive accuracy.

## DISCUSSION

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Top management support significantly enhances M-TPACK (supporting H1), aligning with research on leadership’s critical role in technology-pedagogy integration (Al-Adwan et al., 2025; Dong et al., 2020; Maipita et al., 2023). This study highlights the significant role of top management support in teachers’ adoption of Eduverse technologies in higher education. The Eduverse differs from conventional tools in that it entails significant institutional commitment imposed by the technical and pedagogical shifts demanded. Leadership support, through strategic vision, resource allocation, and recognition of innovation, inspires teachers to use these immersive technologies. In addition to resources, visible leader engagement at the university level (e.g., attending training or publicly endorsing successful implementations) served to legitimize Eduverse adoption. Within Jordan’s hierarchical top-down academic structure, support from top management is especially crucial in soothing risk-averse teachers and reconciling Metaverse-led instruction with organizational objectives.

H2 is supported as facilitating conditions significantly enhance M-TPACK, consistent with evidence that institutional support bolsters Metaverse pedagogical skills (Al-Adwan et al., 2025; Tram, 2025). This study has confirmed that teachers’ adoption of Eduverse technologies requires enabling conditions that lessen the technological demand and resource needs of the technologies. Technical infrastructure, technical support, training, and discovery time are the key determinants. Adoption of Eduverse technology is unlike the less demanding technologies, which require huge institutional investment in hardware, software, and professional support. As teachers perceive robust institutional readiness, their implementation concerns decline, with rising adoption intentions. Additionally, general facilitating conditions underpin managing cognitive loads involved in designing and presenting immersive learning, in addition to fostering adoption in higher education.

H3a is supported, as M-TPACK significantly impacts self-efficacy. This finding is consistent with the literature (Al-Adwan, Meet, et al., 2024; Al-Adwan et al., 2025). The findings reveal that M-TPACK significantly enhances teachers’ self-efficacy in implementing Eduverse technology. This is driven by competence development, as teachers gain specialized knowledge at the intersection of Metaverse technology, pedagogy, and content. This finding extends prior research on TPACK and self-efficacy to Metaverse applications, showing that mastering these unique competencies, such as spatial awareness and immersive content design, boosts teachers’ confidence in using Eduverse environments effectively.

M-TPACK significantly increases perceived usefulness (supporting H3b), consistent with prior research (Al-Adwan et al., 2025; Jang et al., 2021; Thohir et al., 2023; J. Yang et al., 2021). The more familiar the teachers are with the contribution of Metaverse spaces in advancing pedagogy, the more value they see in the use of such technologies. This extends TPACK research by demonstrating its relevance in VR learning environments, where technical knowledge enables key Metaverse affordances like spatial presence and embodied interaction.

M-TPACK significantly enhances perceived ease of use (supporting H3c), aligning with prior findings (Al-Adwan, Meet, et al., 2024; Jang et al., 2021; Ko & Shin, 2023). As teachers develop integrated know-how regarding how to utilize Metaverse technologies for education, the perceived complexity of the technologies reduces. Unlike general tech skills, M-TPACK equips educators with specialized knowledge to effectively leverage Metaverse affordances. This reduces technical issues and boosts their willingness to adopt Eduverse technologies, making it easier and more intuitive to adopt them.

H4a is supported, with Metaverse self-efficacy having a positive impact on Eduverse adoption intention, consistent with the results of Joo et al. (2018) and Menabò et al. (2021). Since self-efficacy directly drives adoption intention, institutions should implement competency-building programs (e.g., professional development, simulations, workshops) to boost adoption rates. This is particularly pertinent in developing regions like Jordan, where uncertainty avoidance and digital readiness vary across institutions. Equipping faculty with Metaverse competencies can drive widespread adoption of immersive learning in higher education.

In addition, the results support H4b, indicating that Metaverse self-efficacy has a significant positive effect on perceived usefulness. While consistent with established self-efficacy-adoption research (Al-Adwan et al., 2025; Usman et al., 2020), this study advances theory by demonstrating these relationships in immersive 3D learning environments. Teachers' Metaverse self-efficacy strengthens their perception of its educational value, particularly for delivering engaging, context-rich learning.

H5 is found to be supported, indicating that the perceived usefulness of Metaverse has a significant positive influence on teachers' intention to adopt Eduverse. This finding aligns with TAM, where perceived usefulness consistently emerges as a strong predictor of technology adoption. Teachers adopt Eduverse when recognizing its pedagogical benefits, confirming perceived usefulness as a critical adoption factor (Al-Adwan, Meet, et al., 2024; Al-Adwan et al., 2025; Chua & Yu, 2024).

H6a is supported, demonstrating that the perceived ease of use of the Metaverse positively influences teachers' intention to adopt Eduverse. Teachers who perceive the Metaverse as intuitive exhibit higher adoption rates, confirming TAM's core premise that ease of use drives technology acceptance. The result is also consistent with previous research that emphasized the importance of usability in driving adoption intentions in educational technology contexts (Ali et al., 2025; Mehta et al., 2025).

The supported H6b demonstrates that easier-to-use Metaverse platforms are perceived as more instructionally useful. This aligns with TAM, where ease of use indirectly influences behavioral intention through perceived usefulness. These results confirm the theoretical relationship and align with established educational technologies adoption patterns (Al-Adwan, Meet, et al., 2024b, 2025).

Digital organizational culture significantly moderates how perceived usefulness and ease of use influence adoption intention (supporting H7b and H7c). Innovation-driven institutions enhance the adoption impact of PEU/PU through three key mechanisms: robust infrastructure, responsive support, and an experimental culture. When institutions recognize and reward technological innovation, teachers' perceptions of usefulness and ease of use have a stronger influence on their adoption decisions. Although underexplored in prior research, this study reveals the significant moderating role of digital organizational culture in how PEU and PU influence Eduverse adoption. Our findings support emerging research (Huang & Teo, 2020; Mahara et al., 2021; Sun & Yan, 2025), which confirms the amplifying role of digital organizational culture in the relationship between PEU/PU and adoption intention.

Interestingly, digital organizational culture showed no significant moderating effect on the self-efficacy-adoption relationship, resulting in H7a rejection. While the moderating effect of digital organizational culture on the link between Metaverse self-efficacy and adoption intention has not been extensively explored, this finding contrasts with previous studies that highlight digital organizational culture as a pivotal factor in shaping teacher self-efficacy and professional behavior (Alshuhumi et al., 2025; Choong et al., 2024; Nordin et al., 2017). One possible explanation is that self-efficacy related to Metaverse adoption is primarily influenced by individual rather than institutional factors, such as teachers' technical competencies, personal motivation, and confidence. Furthermore, general digital organizational culture may not provide the specific, targeted support required to enhance Eduverse-related self-efficacy. The academic autonomy commonly found in higher education settings might also diminish the moderating effect of institutional culture.

## RESEARCH IMPLICATIONS

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### *THEORETICAL IMPLICATIONS*

This study advances theoretical understanding of higher education teachers' Eduverse adoption through an integrated multi-theoretical framework. The introduction of M-TPACK as a pivotal construct extends the traditional TPACK framework into immersive educational environments, addressing a critical gap in the literature regarding how teachers' technological, pedagogical, and content knowledge apply to XR technologies. The model's robust explanatory power ( $R^2 = 0.601$ ) empirically validates this extension, demonstrating that M-TPACK is even more consequential in 3D virtual learning spaces than in conventional digital contexts. Metaverse teaching environments are inherently complex, and the specialised M-TPACK knowledge is a critical driver of adoption intention.

Traditional TAM studies in education often have limited explanatory power, as they fail to account for the unique dynamics of educational settings (Edumadze et al., 2022; Kemp et al., 2024). However, these models have neglected important but critical organizational and pedagogical factors for successful teaching and learning. In addition, they often overlook the effects of external contextual factors such as institutional policies, infrastructural constraints, and socio-economic conditions, which considerably influence the acceptance of technology in educational settings. These limitations underscore the need for an adapted or extended version of TAM that better addresses the complexities of educational contexts. In response to this gap, the current study contributes to theoretical integration by successfully combining constructs from TAM, UTAUT, SCT, and OST. While traditional TAM studies typically focus on perceived usefulness and ease of use, the superior predictive power ( $R^2 = 0.601$ ) of this study model highlights the limitations of relying solely on these TAM constructs. The findings show that these factors operate synergistically with Metaverse self-efficacy (rooted in SCT) and organizational enablers (such as management support and facilitating conditions), and M-TPACK to offer a more comprehensive understanding of Eduverse adoption intentions. By combining cognitive factors of the individuals with institutional dynamics, this hybrid approach outperforms single-theory models and provides a more holistic view of the technology adoption in educational settings.

Moreover, the study advances institutional views on technology adoption by validating the moderating role of digital culture and support. The model's high explanatory power shows that strong Metaverse-TPACK alone doesn't ensure adoption without institutional support. This insight extends OST by demonstrating how organizational readiness interacts with individual competencies and perceptions to shape adoption outcomes. Through this integration, this study fills gaps in the literature and presents a novel line of inquiry for examining emerging educational technology for use at individual, pedagogical, and organizational levels.

From a practical standpoint, the model's high predictive power offers clear guidance for HEIs and policymakers. The results suggest that successful Eduverse adoption requires three interdependent strategies: developing teachers' Metaverse-TPACK through targeted training, ensuring strong leadership support and institutional readiness, and designing Metaverse tools that emphasize both educational value (PU) and usability (PEOU). This comprehensive approach is necessary because the model demonstrates that even highly skilled teachers (high TPACK) may not adopt the technology without adequate institutional support (facilitating conditions, digital organizational culture) and positive perceptions of its utility. The 60% explanatory power thus serves as both a validation of the model's theoretical foundations and a practical roadmap for implementation.

### *PRACTICAL IMPLICATIONS*

The findings on the facilitative effect of top management commitment and facilitation conditions on M-TPACK development have important practical implications for HEIs. University leadership should demonstrate commitment through strategic resource allocation, faculty recognition programs, clear vision communication, and cross-departmental collaboration initiatives that position Eduverse

technologies as institutional priorities. Concurrently, HEIs must establish empowering, facilitating conditions by making investments in robust technical infrastructure, implementing tiered training schemes, building specialist pedagogical support staff, creating communities of practice, and adjusting institutional policies to suit the unique requirements of Metaverse-based teaching (Jing et al., 2025). The coordinated combination of top-down leadership and bottom-up support establishes a complete ecosystem that advances both M-TPACK competencies and institutional Eduverse integration.

Being that M-TPACK has already been shown to impact ease of use, usefulness, and self-efficacy, HEIs must shift from siloed technical training to integrated programs that create those with technical-pedagogical-content-mastery to effectively implement Eduverse (Diamah et al., 2022). This should be a phased transition towards Metaverse integration undertaken by institutions with basic applications before advanced uses through the introduction of peer mentoring systems. Universities can also invest in building discipline-specific Eduverse resources, develop frameworks to assess M-TPACK competencies, and establish a dedicated technical support system. By looking at these dimensions holistically, institutions can enable the integration of Metaverse technologies by teachers and increase their confidence in using the technology while improving the teachers' perceived educational value.

Practically, ease of use, usefulness, and self-efficacy of Eduverse have positive influences on employing Metaverse-based pedagogy from HEIs. Institutions should promote the adoption of Eduverse platforms with intuitive interfaces, easy-to-use content creation tools, as well as user demonstrations and evidence of the pedagogical benefits (Al-Adwan & Al-Debei, 2024). The development of teachers' self-efficacy requires multi-level teaching development programs, peer mentoring programs, technical expertise support, and low-risk experiment experiences. Technical sophistication should be balanced with usability in an integrated implementation plan; teaching excellence programs should align with adoption incentives, and evaluation frameworks should measure both technical success and pedagogical success. Systematically addressing these factors supports the integration of the Eduverse into an institution in a way that enhances teaching and student learning in the Metaverse.

Finally, digital organizational culture amplifies the impact of perceived ease of use and usefulness on Eduverse adoption, providing critical strategic guidance for HEIs (Elbolok et al., 2025). Institutions should foster digital cultures that champion Metaverse teaching through strategic vision-setting and recognition of early adopters. Strategic resource allocation is essential, including infrastructure investments that reduce technical barriers and dedicated time for faculty to develop Eduverse teaching materials. Professional development should align with institutional values and be structured as collaborative learning communities focusing on both technical skills and pedagogical applications (Hladun et al., 2025; Savitska et al., 2025). Leadership demonstrating personal engagement with Eduverse and fostering cross-unit collaboration amplifies the culture's impact on adoption. On top of this, Institutions should also enact three key policies for adoption: (1) flexible evaluation metrics, (2) open resource sharing guidelines, and (3) peer mentorship initiatives. Through these strategic approaches, digital organizational culture can become the most powerful leverage mechanism for Eduverse adoption in higher education.

## CONCLUSION

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This study identifies key factors driving Eduverse adoption among Jordanian university teachers. By integrating TAM, UTAUT, TPACK, SCT, and OST into a unified framework, the research uncovers how individual competencies (such as M-TPACK and self-efficacy), technological factors (perceived ease of use and usefulness), institutional enablers (top management support and facilitating conditions), and digital organizational culture interact to shape teachers' attitudes and behaviors toward Metaverse adoption. The findings confirm that both technical and pedagogical readiness, along with leadership engagement and infrastructural support, are critical to fostering adoption. Furthermore,

the newly introduced M-TPACK construct demonstrates strong predictive validity in immersive learning contexts, expanding existing theoretical boundaries. This study highlights that while perceived usefulness and ease of use remain central to adoption decisions, their effects are magnified in innovative-friendly institutional cultures. Importantly, the results reinforce the need for targeted, context-aware strategies that support teachers in developing the necessary confidence and competence to integrate immersive technologies into their teaching practices. These insights offer theoretical enrichment and practical implications for driving successful Eduverse implementation in resource-constrained higher education settings.

This study significantly contributes to the understanding of the Metaverse adoption by combining a strong theoretical framework of TAM, UTAUT, TPACK, SCT, and OST. By bringing these constructs together in a single framework, the research highlights the complexity between individual perceptions, pedagogical preparedness, and institutional enablers. The synthesis of these theories provides a comprehensive model of how Eduverse adoption can be explained, showing how technological, human, and organizational factors combine to form a whole instead of working in siloed isolation. Methodologically, the conceptualization and empirical validation of the Metaverse-TPACK (M-TPACK) construct represent an important extension of previous models, as it expands TPACK to immersive 3-D worlds while demonstrating how teachers' pedagogical knowledge is integrated into virtual learning environments. The inclusion of digital organizational culture as a moderating variable provides an additional link between theoretical presumptions and empirical observation in order to show how institutional culture influences adopter behavior in practice. Contextually, the study provides preliminary empirical evidence from Jordanian universities, thereby offering nuanced insights into the issue of technology adoption in developing economies. These results highlight the applicability of the proposed model more broadly, as they demonstrate the model's flexibility across different educational systems and cultural contexts.

### ***LIMITATIONS AND FUTURE WORK***

While providing valuable insights on Eduverse adoption in higher education, this study has limitations. First, this study's focus on Jordanian universities limits generalizability, as cultural and institutional differences may affect Eduverse adoption elsewhere. Future research should consider cross-country comparisons to explore cultural and infrastructural differences in Eduverse adoption. Second, the cross-sectional design limits temporal insights; longitudinal tracking could reveal how teachers' M-TPACK and adoption intentions develop. Third, while integrating multiple theories, the model could be enhanced by including psychological (e.g., digital fatigue) and contextual (e.g., institutional change readiness) variables. Future studies should employ mixed methods, integrating quantitative modeling with qualitative insights (e.g., interviews) to better understand teachers' immersive technology experiences.

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## APPENDIX (QUESTIONNAIRE FORM)

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### ***M-TPACK*** (Al-Adwan et al., 2024a, 2025)

**TPACK\_1:** I can design and deliver lessons that seamlessly integrate educational content, metaverse technologies (e.g., VR/AR), and pedagogical strategies to create immersive learning experiences.

**TPACK\_2:** In my classroom, I can apply methods that combine subject-specific content, metaverse tools (e.g., digital avatars), and innovative teaching strategies aligned with curricular goals.

**TPACK\_3:** I can select metaverse-based technologies (e.g., 3D simulations) to enhance the depth, accessibility, and engagement of lesson content.

**TPACK\_4:** I can choose metaverse platforms or tools that transform what I teach, how I teach it, and how students interact with content in virtual spaces.

**TPACK\_5:** I can develop courses with metaverse technologies and pedagogies for real-world applications.

**TPACK\_6:** I can design lessons that blend science, technology, engineering, and math (STEM) with metaverse tools and student-centered teaching approaches.

**TPACK\_7:** I can lead collaborative initiatives in my school or community to coordinate the ethical and effective use of metaverse technologies, content, and pedagogies.

**TPACK\_8:** I am capable of designing assessment frameworks that evaluate learning outcomes within metaverse environments, ensuring alignment with content mastery and skill development.

**TPACK\_9:** I can adapt pedagogical strategies to address ethical, cultural, and accessibility challenges unique to the metaverse (e.g., digital identity, privacy, equity in virtual access) while ensuring inclusive and equitable learning experiences for diverse students.

### ***Top Management Support*** (Al-Adwan et al., 2025; T. M. Nguyen et al., 2022)

**TOP\_1:** University leaders will make it clear that using metaverse tools for teaching is a key goal.

**TOP\_2:** Top managers could actively promote metaverse use by sharing support and resources for teachers to design courses with it.

**TOP\_3:** Senior leaders would set aside money for tech, tools, and training to help teachers use metaverse classrooms.

### ***Metaverse Self-efficacy*** (Joo et al., 2018)

**SEE\_1:** I am confident that I can effectively teach all required course content in the metaverse, even when working with students who find virtual learning challenging.

**SEE\_2:** I am confident that I will continually develop new skills to adapt to evolving metaverse technologies and pedagogical strategies, ensuring I meet my students' needs in digital environments.

**SEE\_3:** I am confident that my dedicated efforts in the metaverse will positively influence my students' academic progress and personal development, even in immersive or unfamiliar virtual settings.

**SEE\_4:** I am confident in my ability to implement innovative metaverse-based assignments and projects, even when encountering skepticism or resistance from others about virtual teaching methods.

### ***Digital Organizational Culture*** (Martínez-Caro et al., 2020)

**CUL\_1:** The teams collaborate effectively on initiatives for innovation and digital transformation.

**CUL\_2:** There is a clear focus on digital technology changes within the company's culture.

**CUL\_3:** The culture of digital innovation and change is a natural part of the company's processes.

**CUL\_4:** The organization shares its digital strategy with staff and considers their suggestions.

### ***Facilitating Conditions*** (Meet et al., 2022)

**FC\_1:** Consistent access to robust technological resources (e.g., hardware, software, connectivity) is ensured to maintain seamless engagement with metaverse platforms.

**FC\_2:** Users and organizations have opportunities to build and refine competencies required to effectively navigate, create, and adapt within evolving metaverse environments.

**FC\_3:** Dedicated technical assistance (e.g., help desks, expert teams) is readily accessible to troubleshoot metaverse-specific challenges and ensure uninterrupted participation.

***Perceived Ease of Use* (Al-Adwan & Al-Debei, 2024)**

**PEU\_1:** I will find it easy to adopt metaverse platforms for teaching in the future.

**PEU\_2:** Metaverse tools could make my classroom workflows more intuitive and streamlined.

**PEU\_3:** I would be able to navigate metaverse features effortlessly for instructional purposes.

**PEU\_4:** Integrating metaverse technology might simplify how I design and deliver lessons.

***Perceived Usefulness* (Al-Adwan et al., 2023)**

**PU\_1:** Using metaverse-based tools in the classroom could enhance my teaching effectiveness.

**PU\_2:** Metaverse platforms would enable me to complete teaching tasks more efficiently.

**PU\_3:** My productivity in instructional activities might increase if I incorporate the metaverse.

**PU\_4:** Overall, metaverse technologies could become highly beneficial to my educational practice.

***Eduverse Adoption Intention* (Al-Marroof et al., 2024)**

**INT\_1:** I intend to use metaverse platforms for teaching/learning activities in the near future.

**INT\_2:** I am willing to incorporate metaverse-based tools into my regular educational practice.

**INT\_3:** I plan to explore how the metaverse can be integrated into my work as an educator/student.

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