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Formation of a future teacher's competence in the digital landscape: the metaverse as a new paradigm of education

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Abstract

The study conceptualizes the metaverse as a transformative educational paradigm that integrates immersive virtual environments, simulation-based learning, and collaborative digital interaction into teacher education. The research is based on qualitative theoretical analysis, systematic literature review, thematic synthesis, and exploratory unstructured interviews with students of the Faculty of Educational Sciences at the University of Lodz. The findings demonstrate that metaverse technologies contribute to development of digital, pedagogical, communicative, reflective, intercultural, and adaptive competencies required for professional activity within Education 5.0 environments. Particular attention was paid to pedagogical integration of constructivist learning theory and Kolb's experiential learning cycle within immersive educational ecosystems. The study proposes an Integrated Constructivist–Experiential Model of Metaverse-Based Teacher Competence Formation, explaining how immersive environments support experiential engagement, reflective observation, conceptual knowledge construction, and adaptive pedagogical experimentation. The results also identify major implementation challenges, including technological inequality, insufficient digital literacy, ethical concerns, and psychological risks associated with immersive education. Findings demonstrate that the metaverse possesses significant potential for transforming teacher education, provided that its implementation remains pedagogically grounded, ethically responsible, and human-centered.

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Keywords

Metaverse, teacher competence, digital education, immersive learning, Education 5.0, experiential learning, constructivism, virtual reality, teacher training, digital pedagogy, higher education, professional development

INTRODUCTION

The fast pace of digital transformation in contemporary societies led to evident reshaping of educational systems, pedagogical models, and the professional competencies required of teachers in the twenty-first century. The emergence of artificial intelligence, immersive technologies, extended reality (XR), virtual reality (VR), augmented reality (AR), as well as blockchain-based environments accelerated the transition from traditional educational paradigms toward highly interactive and technology-mediated learning ecosystems. Among these innovations, metaverse 'toolkit' gained particular scholarly and practical attention as a multidimensional virtual environment capable of redefining educational interaction, communication, and professional training. In the context of teacher education, metaverse is increasingly viewed not merely as a technological tool, but as a new educational paradigm that transforms the formation of professional competence in future educators. The metaverse is rapidly emerging as innovative paradigm in education, moving beyond traditional 2D screen-based learning to create immersive, 3D virtual environments that increase student engagement, retention, and motivation. Tools of XR offer a "learning-by-doing" approach that allows students to explore complex phenomena in a cost-effective and interactive manner (Cherner & Fegely, 2023). Table 1 below briefly summarizes key aspects of the educational metaverse, as well as benefits/impact and challenges.

Table 1

Key aspects, benefits/impact, and challenges of the educational metaverse

Key Aspects of the Educational Metaverse
Immersive Learning Environments: Virtual classrooms, laboratories, and simulation sites enable students to experience scenarios impossible in real life, such as exploring historical sites
Active and Personalized Learning: The metaverse transforms passive learners into active participants, offering tailored, personalized experiences that foster creative and collaborative skills.
Social Connection: Through avatars, students can interact, communicate, and collaborate with peers and teachers from around the world in real-time, facilitating social-emotional learning and bridging geographical gaps.
Technology Integration: The Edu-Metaverse integrates with other emerging technologies, including artificial intelligence (AI), blockchain, and the Internet of Things (IoT), to create highly advanced, secure, and personalized learning systems.
Benefits and Impact
Enhanced Retention: Research suggests that immersive VR experiences can increase knowledge retention to over 75%, compared to significantly lower rates for traditional methods.
Improved Accessibility: The metaverse offers accessibility to high-quality education and simulations, reducing costs associated with physical labs and materials.
Increased Motivation: By incorporating game-like elements and interactive quests, the metaverse boosts engagement and makes learning more enjoyable, leading to higher academic performance and improved attention spans.
Challenges and Future Outlook
Technological Hurdles: Widespread adoption faces challenges related to infrastructure, cost of equipment, and technological literacy.
Ethical and Privacy Concerns: Data security, privacy, and the psychological impact on users require careful, ongoing research and regulation.
Pedagogical Shift: Educators must transition from traditional teaching roles to facilitating learning in 3D digital worlds, requiring new training and strategies.

Source: Jindal *et al.* (2024); Kabilan (2023); Muthmainnah *et al.* (2025); Serhieiev *et al.* (2025)

The concept of metaverse refers to interconnected immersive digital spaces where users interact through avatars within persistent three-dimensional environments that combine social, educational, and technological experiences. Unlike conventional online learning platforms, metaverse-based education enables synchronous interaction, experiential learning, embodied participation, and simulation-driven pedagogical practice. These characteristics became especially relevant in the post-pandemic educational landscape, where hybrid and blended learning models exposed the limitations of traditional digital instruction

and highlighted the necessity of more engaging and adaptive educational environments (Jotania *et al.*, 2021). The growing integration of metaverse into education reflects broader global trends associated with digitalization, personalization of learning, and the increasing demand for digitally competent educators. Contemporary teachers are expected not only to possess subject knowledge and pedagogical expertise, but also to effectively navigate digital ecosystems, implement immersive technologies, and facilitate collaborative learning in virtual environments. Consequently, the formation of professional competence in future teachers increasingly depends on their ability to operate within complex digital landscapes characterized by continuous technological innovation and changing modes of communication.

Within this context, the metaverse offers significant opportunities for teacher training and professional development. One of its most valuable features is the creation of immersive simulations that allow future teachers to practice pedagogical strategies and classroom management techniques in realistic virtual environments before entering actual classrooms. Simulation-based training enables prospective educators to develop confidence, decision-making abilities, communication skills, and adaptive pedagogical responses without the risks associated with real-world teaching failures. Such experiential learning environments bridge the longstanding gap between theoretical preparation and practical application in teacher education programs. Moreover, the metaverse overcomes geographical and physical limitations that traditionally restrict educational access and collaboration. Through immersive virtual spaces, future teachers from various regions and countries can participate in shared educational experiences, collaborative projects, and real-time professional interaction. This global connectivity contributes to development of intercultural competence, collaborative problem-solving skills, and international professional networks, all of which are increasingly important in contemporary education systems. The metaverse therefore supports the creation of borderless educational communities that extend beyond institutional and national boundaries.

Another important advantage of metaverse-based teacher education lies in its capacity to enhance learner engagement and motivation. Immersive environments stimulate active participation

through interactive content, gamified experiences, and embodied learning activities that are difficult to reproduce in conventional online education. Future teachers trained within such environments gain firsthand experience with innovative pedagogical approaches that can later be transferred into their own teaching practice. Simultaneously, exposure to AR and VR technologies contributes to the formation of digital competence, technological literacy, and creative instructional design skills that are essential for modern educators (Llanos-Ruiz *et al.*, 2025; Shumilova *et al.*, 2026). The metaverse also enables personalized and flexible professional training trajectories. Unlike standardized traditional educational models, immersive digital environments can adapt to individual learning styles, professional needs, and levels of technological preparedness. Future teachers may repeatedly practice specific scenarios, explore complex educational situations through experiential learning, and receive immediate feedback within controlled virtual settings. Such flexibility enhances the efficiency of professional preparation and supports continuous competence development in rapidly changing educational contexts (Ajani, 2023).

Despite these advantages, the implementation of the metaverse in teacher education remains associated with multiple challenges and critical considerations. One of the primary barriers concerns the insufficient level of digital literacy among both educators and students. Effective participation in immersive virtual environments requires advanced technological skills, familiarity with digital communication tools, and the ability to navigate complex virtual systems. Additionally, technical difficulties, high implementation costs, infrastructural limitations, and unequal access to digital technologies may contribute to educational inequality and limit the scalability of metaverse-based learning.

Another significant challenge involves the pedagogical adaptation of immersive technologies. The successful integration of the metaverse into teacher education requires not only technological infrastructure, but also specialized pedagogical models capable of transforming immersive experiences into meaningful educational outcomes. Without appropriate methodological frameworks, the metaverse risks becoming a purely technological innovation lacking pedagogical effectiveness. Consequently, teacher education institutions must develop targeted training programs that prepare future educators to critically and

effectively integrate immersive technologies into their professional practice.

Current scholarly discourse demonstrates that although traditional teacher training models continue to dominate educational systems, the transition toward immersive digital environments is becoming increasingly necessary in response to the demands of contemporary education (Mena-Guacas *et al.*, 2025). Researchers emphasize that post-pandemic educational realities, combined with the expansion of hybrid and blended learning, require new approaches to competence formation that integrate technological innovation with pedagogical adaptability (Hasim *et al.*, 2025). In this regard, the metaverse represents not only a technological advancement, but also a transformative educational space capable of redefining professional preparation, interaction, and identity formation among future teachers. At the same time, the integration of the metaverse into teacher education raises broader philosophical and ethical questions regarding digital identity, psychological well-being, data security, accessibility, and the preservation of human-centered pedagogy in virtual environments. The increasing virtualization of educational interaction necessitates a reconsideration of the balance between technological innovation and the social-emotional dimensions of teaching. Therefore, the formation of teacher competence within the digital landscape must include not only technological readiness, but also ethical awareness, critical digital thinking, and the capacity to maintain meaningful interpersonal communication in immersive educational settings.

Given these transformations, there is a growing need for comprehensive scholarly analysis of how the metaverse influences the formation of future teacher competence and what pedagogical conditions ensure its effective implementation in higher education. Although recent studies increasingly examine immersive technologies in education, there remains insufficient conceptualization of the metaverse as a holistic paradigm for professional teacher preparation. In particular, further research is required to identify the competencies most significantly affected by immersive learning environments, the pedagogical models suitable for metaverse-based education, and the challenges associated with integrating these technologies into teacher training systems.

With this in mind, the study makes an attempt to analyze the role of the metaverse in the formation of future teacher competence within the contemporary digital landscape, to identify its pedagogical potential and limitations, and to determine the key conditions necessary for the effective implementation of immersive technologies in teacher education. The study also seeks to conceptualize the metaverse as a transformative educational paradigm that reshapes professional training, digital interaction, and competency development in higher education institutions.

LITERATURE REVIEW

Digital Transformation of Teacher Training

Digitalization of education fundamentally transformed the conceptual foundations of teacher training and professional competence formation. Many scholars and experts today emphasize that contemporary educational systems increasingly require future teachers to operate effectively within technologically enriched environments characterized by virtual communication, online collaboration, digital content creation, and data-driven pedagogical practices (Zou *et al.*, 2025). As a result, traditional understanding of teacher competence expanded beyond subject knowledge and classroom pedagogy, and 'organically' integrated digital literacy, technological adaptability, media competence, and the ability to facilitate learning in virtual and hybrid educational contexts. In particular, Reis *et al.* (2024) emphasize that the use of virtual environments in educational processes became a reality, and even at different levels, it is observed in the daily life of educational institutions.

Recent literature highlights that the post-pandemic educational landscape significantly accelerated the transition toward digitally mediated learning (Bitar & Davidovich, 2024)). The COVID-19 crisis exposed structural limitations of traditional educational systems and demonstrated the necessity of flexible, technology-supported pedagogical models capable of ensuring continuity of learning under conditions of social disruption. Consequently, teacher education institutions worldwide began intensifying efforts to develop digital competencies among future educators, particularly competencies

associated with online communication, virtual classroom management, and technology-enhanced pedagogical design (Nagel & Amdam, 2025).

Within this context, scholars increasingly argue that digital competence should not be understood merely as technical proficiency, but rather comprehended as an integrated professional capacity that combines technological knowledge with pedagogical, communicative, ethical, and critical thinking skills (Asagar, 2025). The formation of such competence requires the creation of innovative educational environments where future teachers can actively engage with emerging technologies and develop practical experience in digitally mediated teaching practices. This shift contributed to growing academic interest in immersive educational technologies, particularly the metaverse, as a transformative space for professional teacher preparation.

Conceptualizing the Metaverse in Education

Researchers emphasize that the metaverse represents a new stage in the evolution of digital education, since it shifts learning from passive information consumption toward embodied participation and experiential engagement (Roy *et al.*, 2023). Educational interaction within the metaverse is characterized by immersion, presence, collaboration, and simulation-based learning, which collectively contribute to more active forms of knowledge construction. These characteristics align with constructivist and connectivist pedagogical theories that view learning as a socially situated and interactive process (Dacholfany *et al.*, 2022). H. Lin *et al.* (2022) discuss some key elements of the Metaverse in education, such as the personal teaching and learning environments. The writers speculate on what versions of this combination will bring to schooling in the future and explore their advantages and disadvantages. L. Lim *et al.* (2025) present the results of scoping review examining 10 metaverse studies and 41 virtual world studies. It reveals that: I) the metaverse incorporates a variety of cutting-edge technologies, such as cloud computing and xReality, whereas the virtual world relies more on traditional technological architectures; II) both environments extend social learning beyond the classroom, but virtual world studies offer more detailed guidance for educators; III) familiarizing students with the operation of both environments is

thought to be useful to reduce cognitive load when undertaking complex learning tasks; IV) educators frequently confuse learning theories and instructional strategies in relation to practices within both environments; and V) social learning activities in both environments generally improve student performance, though the results are mixed and context-dependent.

The Metaverse as an Environment for Teacher Competence Formation

One of the central themes in recent educational research concerns the role of the metaverse in the formation of professional teacher competence. Scholars argue that immersive virtual environments provide unique opportunities for integrating theoretical knowledge with practical pedagogical experience. Through simulation-based learning, future teachers can participate in realistic classroom scenarios, practice instructional strategies, develop classroom management skills, and respond to diverse educational situations within controlled virtual settings. An interesting study is presented by HyeJin and Yohan (2023) – a research on training pre-service teachers as metaverse-certified practitioners. Specifically, 40 pre-service teachers were involved in "training *with, about, for* metaverse (TM)" to convert high-stakes TOEIC test items into virtual content. The results showed that pre-service teachers had a very positive overall reaction to the TM experience. Facilitating environments, effort expectation, and hedonic motivation all showed notable gains. The TM framework changed pre-service teachers' perceptions on teaching, assessment, and learning, according to text-mining data.

Matović *et al.* (2025) consider teachers' perspectives on benefits and challenges of metaverse in education. The findings imply that educators usually have a favorable opinion of the metaverse in the classroom, appreciating its ability to explore distant and abstract subjects and improve instructional effectiveness. However, material-technical constraints and worries about the possible dehumanization of schooling provide a serious obstacle. Inadequate training for the application of artificial intelligence-based concepts in education is a contributing factor in teachers' reluctance to innovative teaching approaches. In order to guarantee the efficient and pedagogically

intentional use of technology, the findings emphasize the necessity of systematic professional development and support its incorporation into basic teacher education curriculum. Shamsudin *et al.* (2024) explore the perceptions of teacher trainees regarding the implementation of metaverse technologies in their training programs at higher education institutions. A mixed-methods approach was used, with a survey distributed to 300 teacher trainees, followed by in-depth interviews with a subset of participants. The findings show that the metaverse is seen positively as an innovative and engaging learning environment that can improve interactivity, collaboration, and real-world simulation in teacher training. However, concerns are voiced about the metaverse's technical problems, learning curve, and potential distractions. Participants also noted a need for proper training and assistance to effectively use metaverse technologies into their teaching practices. The study concludes with recommendations for universities and teacher training institutions to provide the infrastructural, technical, and pedagogical support required for the successful application of metaverse technologies in teacher education programs.

Another important dimension of competence formation within metaverse environment/ecosystem relates to collaborative learning and communication. Virtual educational environments facilitate interaction between participants regardless of geographical location, thereby supporting international cooperation, intercultural dialogue, and collective problem-solving. Studies demonstrate that collaborative experiences within immersive environments contribute to the development of communication competence, teamwork skills, and professional networking capacities that are increasingly important in globalized educational systems (Zamiri & Esmaeili, 2024).

The metaverse' pedagogical value is closely connected with broader research on immersive technologies and experiential learning. A range of studies indicate that virtual reality and augmented reality enhance educational effectiveness by increasing immersion, emotional engagement, and active participation (Rodolico & Hirsu, 2023). Experiential learning theories suggest that knowledge is constructed most effectively through direct experience, reflection, experimentation, and interaction with realistic contexts. The metaverse operationalizes these principles by creating educational environments where learners

actively participate in dynamic and meaningful experiences (Bazargani *et al.*, 2025).

Research gap

Despite the fact that scholarly interest in the educational metaverse expanded rapidly in recent years, research domain in this field still 'retains' rather evident gaps. First, many existing studies focus predominantly on technological capabilities rather than on the pedagogical and competency-based dimensions of immersive education. There is still limited research examining how the metaverse systematically influences the formation of professional teacher competence across cognitive, communicative, ethical, and reflective domains. Moreover, insufficient attention is paid to the integration of metaverse technologies within broader theoretical frameworks of teacher professionalization. Existing research often examines immersive technologies independently from contemporary theories of digital pedagogy, connectivism, experiential learning, and competency-based education.

With this in mind, the present study represents an attempt to address these gaps by examining metaverse as a multidimensional educational environment that reshapes the formation of future teacher competence within the contemporary digital landscape. Particular attention is paid to the pedagogical opportunities, professional implications, and institutional conditions associated with immersive teacher education in higher education systems.

METHODOLOGY

Research Design

The study employs a qualitative theoretical-analytical research design aimed at examining the role of the metaverse in the formation of future teacher competence within the contemporary digital educational landscape. Considering the emerging and interdisciplinary nature of the research topic, the study combines elements of systematic literature analysis, comparative conceptual synthesis, and interpretive pedagogical analysis. Such an approach allows for the comprehensive examination of

theoretical perspectives, technological trends, pedagogical implications, and competency-based dimensions associated with the integration of metaverse technologies into teacher education. The methodological framework is grounded in principles inherent in constructivist pedagogy, competency-based education, digital pedagogy, and experiential learning theory. These theoretical perspectives provide the basis for analyzing how immersive virtual environments influence professional identity formation, pedagogical interaction, and the development of digital competence among future educators.

The study adopts an interdisciplinary perspective that integrates educational sciences, digital learning research, communication studies, and technological innovation analysis. This interdisciplinary orientation is particularly important because the metaverse represents not only a technological phenomenon, but also a socio-pedagogical environment that transforms educational communication, interaction, and professional practice.

Data Collection Strategy

The literature selection process focused primarily on peer-reviewed journal articles, conference proceedings, theoretical studies, and empirical research published between 2020 and 2026. This timeframe was selected due to the rapid expansion of scholarly interest in immersive educational technologies following the global transition toward digital and hybrid learning during and after the COVID-19 pandemic. The search process utilized combinations of the following keywords and thematic categories: "metaverse in education"; "teacher competence and digital transformation"; "immersive learning environments"; "virtual reality in teacher education"; "digital pedagogy"; "future teacher competencies"; "XR technologies in education"; "simulation-based teacher training"; "metaverse and higher education"; "professional development in virtual environments".

To ensure methodological rigor, only studies directly related to educational applications of immersive technologies and teacher preparation were included in the final analytical corpus. Publications focused exclusively on technical engineering aspects without pedagogical relevance were excluded from the analysis.

Theoretical Framework

The study is based on several interconnected theoretical approaches. The constructivist approach (Bou Saad *et al.*, 2025) emphasizes active knowledge construction through interaction, collaboration, and experiential engagement. Within metaverse environments, learners participate directly in immersive educational situations, thereby constructing professional knowledge through practice-oriented experiences. Experiential learning theory (Archer *et al.*, 2026) provides an additional methodological foundation by explaining how immersive simulations contribute to reflective learning, practical experimentation, and competency development. Simulation-based pedagogical practice within virtual environments corresponds closely with experiential models of professional preparation. The competency-based approach (Avidov-Ungar, 2025) is central to the study, since it conceptualizes teacher professionalism as a multidimensional system of knowledge, skills, values, adaptability, and digital literacy. This framework enables the analysis of how immersive technologies influence various dimensions of professional competence formation. Finally, digital pedagogy (Dhakal, 2023) serves as an overarching methodological perspective for understanding the transformation of educational interaction, communication, and instructional design within technologically mediated environments.

Ethical Considerations

The study adheres to general principles of academic integrity, transparency, and ethical scholarly practice. All analyzed sources were properly evaluated according to scientific relevance and methodological credibility. The research does not involve vulnerable human participants, experimental interventions, or personal data collection; therefore, formal ethical approval was not required.

RESULTS AND DISCUSSION

The Metaverse as a Transformative Environment for Teacher Competence Formation

The analysis of contemporary scholarly discourse demonstrates that the metaverse is gradually transforming from an experimental technological concept into a significant educational environment capable of reshaping professional teacher training. Unlike conventional digital learning platforms, immersive metaverse environments combine virtual interaction, experiential learning, simulation-based practice, and collaborative communication within persistent three-dimensional spaces (Yuliang *et al.*, 2026). As a result, the metaverse contributes not only to technological modernization of education, but also to the transformation of pedagogical paradigms associated with competence formation in future educators. Evidence demonstrates that the educational potential of metaverse is particularly significant in the context of competency-based and practice-oriented teacher education (Parrales-Bravo *et al.*, 2026). Traditional models of teacher training often face limitations associated with insufficient practical immersion, restricted opportunities for repeated pedagogical experimentation, and the separation between theoretical instruction and authentic professional practice. Immersive virtual environments partially overcome these limitations by enabling future teachers to engage in realistic educational scenarios that simulate classroom interaction, student behavior, collaborative teaching processes, and instructional decision-making.

Moreover, one should note that metaverse aligns closely with the conceptual principles of Education 5.0, which emphasizes human-centered technological integration, creativity, innovation, personalization, collaboration, and the development of adaptive competencies for rapidly changing digital societies. Within the framework of Education 5.0, technology is not viewed as a substitute for human pedagogy, but rather as a mechanism for enhancing meaningful educational interaction, creativity, and experiential engagement (Chigbu & Makapela, 2025). Consequently, the metaverse functions as a platform that supports the transition from content-centered education toward

competence-centered and learner-centered pedagogical ecosystems.

Crucially significant potential of metaverse in training future teachers lies in the fact that participation in metaverse-based educational environments contributes to development of technological literacy, virtual communication skills, digital collaboration, instructional creativity, and adaptive pedagogical thinking (Abdelmagid *et al.*, 2025). At the same time, immersive simulations facilitate formation of reflective competence by allowing pedagogical students to analyze their pedagogical decisions, receive immediate feedback, and modify instructional strategies within safe virtual contexts.

In overall, educational opportunities provided by metaverse technologies in teachers competence-based training within the paradigm of Education 5.0 are systematized in Table 2.

Table 2

Opportunities of the Metaverse in the Formation of Future Teacher Competencies within Education 5.0

Competency Dimension	**Opportunities Provided by Metaverse**	**Relation to Education 5.0**
Digital Competence	Development of skills in VR/AR environments, digital communication, virtual collaboration, and immersive instructional design	Supports technological adaptability and digital literacy
Pedagogical Competence	Simulation-based classroom practice, virtual lesson planning, interactive teaching strategies	Enhances practice-oriented and student-centered learning
Communication Competence	Real-time interaction through avatars, multicultural collaboration, global educational networking	Promotes global connectivity and collaborative learning
Reflective Competence	Repeated simulation experiences with feedback and self-analysis opportunities	Stimulates creativity and innovation
Creative Competence	Gamification, immersive storytelling, design of interactive educational experiences	Stimulates creativity and innovation
Adaptive Competence	Experience in dynamic virtual environments requiring rapid pedagogical decision-making	Develops flexibility and resilience
Intercultural	Participation in international	Strengthens global

Competence	virtual educational communities	citizenship and inclusivity
Emotional and Social Competence	Simulation of complex classroom interactions and emotional scenarios	Supports human-centered educational interaction
Research and Analytical Competence	Access to data-driven educational environments and digital educational analytics	Encourages critical thinking and evidence-based pedagogy
Ethical and Digital Responsibility	Awareness of privacy, digital identity, cyber ethics, and responsible technology use	Reinforces ethical dimensions of Education 5.0

Source: Qian *et al.* (2023), Zhang *et al.* (2022)

Thus, metaverse contributes to formation of multidimensional professional competence rather than isolated technological skills. Importantly, the metaverse supports the integration of cognitive, communicative, emotional, ethical, and technological dimensions of teacher professionalism within a unified immersive educational environment. The relationship between metaverse technologies and Education 5.0 is particularly significant since both paradigms are grounded on personalization, collaboration, creativity, and human-centered innovation.

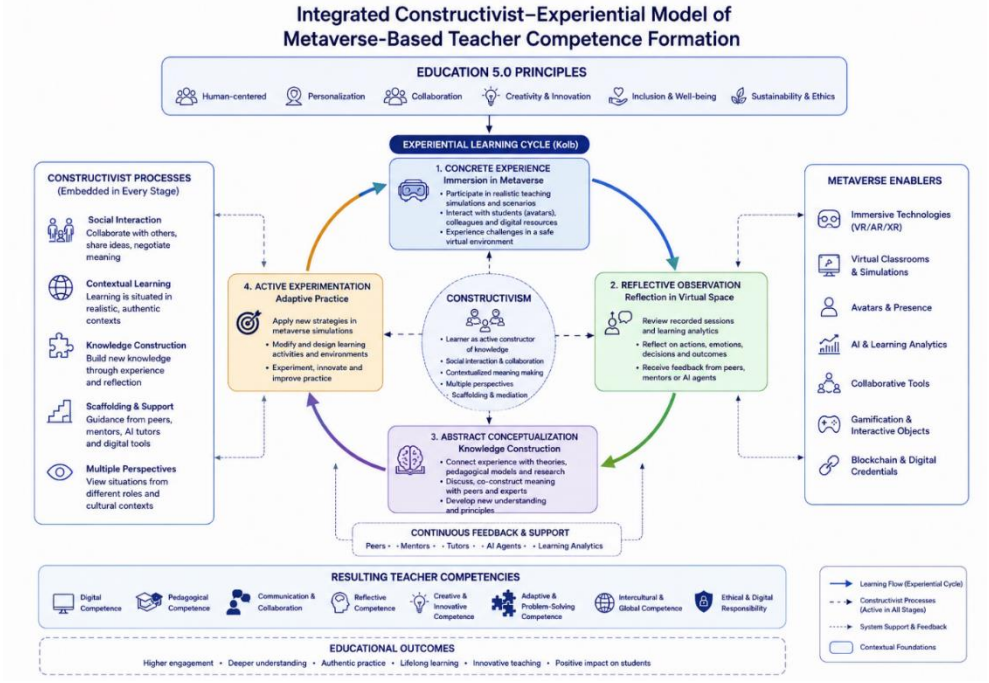
Integrating Constructivism and Experiential Learning in Metaverse-Based Teacher Education. The Metaverse and the Evolution of Education 5.0

Constructivist pedagogy views learning as an active process of knowledge construction that occurs through interaction, collaboration, reflection, and engagement with meaningful contexts. Metaverse environments operationalize these principles by enabling future teachers to actively participate in immersive educational situations rather than passively consume information. Learners interact with digital objects, communicate with other participants, solve pedagogical problems, and construct professional understanding through authentic virtual experiences. At the same time, metaverse-based learning strongly corresponds with experiential learning theory – first of all, Kolb cycle. Immersive educational environments naturally support this cyclical process due to enabling realistic experiences, opportunities for

reflection, conceptual analysis, and repeated practical experimentation. The metaverse, therefore, functions as a kind of pedagogical ecosystem where constructivist interaction and experiential learning represent mutually reinforcing processes. Corresponding integrated constructivist–experiential model of metaverse-based teacher competence formation is presented in Fig. 1 below.

Figure 1

Integrated constructivist–experiential model of metaverse-based teacher competence formation



Source: developed by the authors based on Morris (2020), Wijnen-Meijer *et al.* (2022), Yuliang *et al.* (2026)

The proposed model illustrates the cyclical relationship between immersive experience, reflective analysis, conceptual knowledge construction, and adaptive pedagogical experimentation within metaverse-based teacher education. The model demonstrates that professional competence formation emerges through continuous interaction between experiential learning processes and constructivist pedagogical engagement inside immersive digital ecosystems.

Stage 1 implies immersive concrete experience. Future teachers enter simulated virtual classrooms where they participate in realistic pedagogical situations involving instructional delivery, classroom management, communication with students, and collaborative interaction. At this stage, the metaverse creates experiential immersion that stimulates emotional engagement, active participation, and contextual learning.

Stage 2 refers to reflective observation in virtual space. After participating in immersive simulations, learners analyze their pedagogical behavior, communication patterns, decision-making strategies, and emotional responses. Reflection may occur individually or collaboratively through virtual discussion spaces. The metaverse enhances reflection by enabling replay, observation from multiple perspectives, and peer feedback mechanisms.

Stage 3 consists in abstract conceptualization and knowledge construction. During this phase, future teachers connect their practical experiences with pedagogical theories, instructional models, and professional frameworks. Constructivist learning becomes especially visible because learners actively construct conceptual understanding through interpretation of immersive experiences. The integration of theory with practice strengthens professional comprehension and critical pedagogical thinking.

Stage 4 is based on active experimentation and adaptive practice. On this stage, pedagogical students return to immersive simulations and apply modified instructional strategies based on previous reflection and conceptual understanding. The metaverse enables repeated experimentation without the risks associated with real classroom environments. This cyclical process supports adaptive competence formation, pedagogical flexibility, and continuous professional growth.

Thus, the proposed model demonstrates that metaverse-based teacher education should not be understood solely as technological immersion. Rather, its educational effectiveness emerges from the interaction between experiential engagement, reflective analysis, collaborative knowledge construction, and adaptive pedagogical experimentation. Metaverse, in fact, represents one of the most technologically advanced manifestations of Education 5.0 principles within higher pedagogical education. Education 5.0 differs from earlier

educational paradigms because it prioritizes human-centered technological ecosystems that integrate creativity, emotional intelligence, critical thinking, personalization, and social responsibility alongside digital innovation. Within this framework, future teachers are expected not only to master technological tools, but also to function as facilitators of collaborative, creative, and adaptive learning processes. The metaverse supports this transformation by redefining educational interaction in several ways: from passive learning toward immersive participation; from isolated instruction toward collaborative knowledge ecosystems; from standardized educational models toward personalized learning trajectories; from theoretical abstraction toward experiential pedagogical practice; from local educational environments toward global digital communities.

Exploratory Student Interviews on the Educational Potential of the Metaverse

To complement the theoretical analysis, an exploratory qualitative component was conceptually integrated into the study in the form of unstructured interviews with students of the Faculty of Educational Sciences at University of Lodz (on total, 26 respondents, third-year students of inclusive pedagogy course). The purpose of the interviews was to identify students' perceptions, expectations, concerns, and attitudes regarding the implementation of metaverse technologies in teacher education. The interviews were designed as unstructured reflective conversations aimed at capturing subjective experiences and personal interpretations rather than statistically generalized opinions. Such an approach corresponds with interpretive qualitative methodology and allows for deeper understanding of emerging attitudes toward immersive educational technologies among future educators. The interview participants were asked three open-ended questions: 1) How do you understand the role of the metaverse in future education and teacher training? 2) Would you personally like to study or practice teaching in a metaverse environment? Why? Or why not? Why? 3) What opportunities and risks do you associate with the use of immersive virtual environments in education?

The responses were analyzed using thematic coding principles inspired by grounded theory methodology. During the analytical process,

recurring semantic categories, perceptions, and conceptual patterns were identified and grouped into broader interpretive themes. Analysis demonstrated that students generally perceive metaverse as an innovative and perspective educational environment capable of increasing engagement, practical immersion, and flexibility in teacher preparation. At the same time, respondents expressed concerns regarding technological dependence, reduced face-to-face communication, digital inequality, and possible psychological effects of prolonged immersion in virtual environments. Appropriate thematic categories are summarized in Table 3.

Table 3

Thematic Categories Derived from Student Interviews on the Metaverse in Teacher Education

Core Category	**Subcategory / Code**	**Illustrative Meaning in Student Responses**	**Interpretive Dimension**
Perception of Innovation	"Education of the future"	The metaverse is viewed as a modern and technologically advanced educational environment	Technological optimism
Professional Practice	"Safe pedagogical experimentation"	Virtual classrooms allow future teachers to practice without fear of failure	Practice-oriented learning
Engagement and Motivation	"Learning becomes interactive"	Immersive environments increase attention, participation, and emotional involvement	Student-centered pedagogy
Flexibility and Accessibility	"Education without borders"	Possibility of international collaboration and remote participation	Global educational connectivity
Digital Competence Development	"Teachers must understand technologies"	The metaverse helps future educators develop digital literacy and technological adaptability	Competency formation
Emotional Concerns	"Virtual communication may feel artificial"	Fear of losing authentic interpersonal interaction	Human-centered educational concern

Technological Barriers	"Not everyone has equal access"	Concerns regarding equipment costs and digital inequality	Accessibility challenge
Cognitive and Psychological Risks	"Too much virtual immersion can be exhausting"	Anxiety regarding digital fatigue and overstimulation	Psychological dimension
Pedagogical Transformation	"The role of the teacher will change"	Teachers become facilitators and designers of immersive learning	Transformation of professional identity
Ethical Awareness	"Data privacy and virtual behavior matter"	Awareness of ethical and security issues in immersive environment	Digital ethics

The thematic analysis indicates that future teachers simultaneously associate the metaverse with educational innovation and pedagogical uncertainty. This duality is particularly important because it reflects the transitional nature of contemporary digital transformation in education. On the one hand, students recognize the significant pedagogical potential of immersive technologies for simulation-based learning, creativity, and professional flexibility. On the other hand, they emphasize the importance of preserving human interaction, emotional communication, and ethical responsibility within digitally mediated educational ecosystems. Moreover, the findings demonstrate that pedagogy students perceive immersive technologies not merely as supplementary educational tools, but rather as factors capable of fundamentally transforming the professional role of teachers. Respondents actually described future educators as facilitators of interactive learning environments, moderators of digital collaboration, and 'designers' of personalized educational experiences. Such perceptions strongly correspond with the principles of Education 5.0 and confirm the growing shift toward human-centered technological pedagogy. Importantly, the interviews also revealed a relatively high level of openness toward experimentation with immersive educational technologies. Most respondents expressed willingness to participate in metaverse-based teacher training, particularly for practical pedagogical simulations, international collaboration, and interactive methodological workshops. However, students emphasized that effective implementation would require institutional support, technological

accessibility, pedagogical guidance, and training in digital ethics.

From the perspective of grounded theory interpretation, the central emerging category may be defined as "adaptive pedagogical transformation in immersive digital environments". Consequently, the interview findings support the broader results of the study and confirm that the metaverse is increasingly perceived by future educators as a potentially transformative component of professional teacher preparation within the contemporary digital landscape.

In overall, the conducted study demonstrates that metaverse 'toolkit' represents not merely a technological innovation, but an emerging educational paradigm capable of significantly transforming the formation of professional competence among future teachers within the contemporary digital landscape. The integration of immersive virtual environments into teacher education contributes to the development of multidimensional competencies, including digital literacy, pedagogical adaptability, reflective thinking, intercultural communication, creative problem-solving, and ethical awareness. In contrast to traditional educational models, metaverse-based learning environments provide experiential, simulation-oriented, and collaborative forms of professional preparation that strengthen the connection between theoretical knowledge and practical pedagogical application.

Moreover, the findings confirm that pedagogical effectiveness of immersive technologies is most fully implemented when integrated with constructivist and experiential learning approaches. The proposed Integrated Constructivist–Experiential Model of Metaverse-Based Teacher Competence Formation demonstrates that immersive educational environments support continuous cycles of practical experience, reflective observation, conceptual knowledge construction, and adaptive experimentation. Such an approach corresponds closely with the principles of Education 5.0, which emphasize human-centered technological innovation, personalization, collaboration, creativity, and lifelong learning. At the same time, the study reveals that successful implementation of metaverse technologies in teacher education requires substantial institutional, pedagogical, technological, and ethical preparation. Challenges associated with digital inequality, technological accessibility, pedagogical readiness, psychological well-being, and ethical governance remain significant barriers to sustainable integration.

Therefore, both educational policy-makers and pedagogical education facilities should focus not only on technological modernization, but, first of all, on the development of pedagogically grounded and ethically responsible frameworks for immersive education.

The exploratory interviews with future teachers further indicate that students perceive the metaverse as both a promising educational opportunity and a complex transformative challenge. Their responses reflect growing openness toward immersive educational experimentation alongside concerns regarding authentic communication, accessibility, and digital overdependence. Consequently, the future of metaverse-based teacher education depends on achieving a balanced synthesis between technological advancement and the preservation of human-centered pedagogical interaction.

Overall, the metaverse is characterized with the potential to become one of the key educational environments shaping the next generation of teachers capable of functioning effectively within digitally mediated, globally interconnected, and continuously evolving educational ecosystems.

References

Abdelmagid, A. S., Jabli, N. M., Al-Mohaya, A. Y., & Teleb, A. A. (2025). Integrating Interactive Metaverse Environments and Generative Artificial Intelligence to Promote the Green Digital Economy and e-Entrepreneurship in Higher Education. *Sustainability, 17*(12), 5594. https://doi.org/10.3390/su17125594

Ajani, O. (2023). The Role of Experiential Learning in Teachers' Professional Development for Enhanced Classroom Practices. *Journal of Curriculum and Teaching, 12*(4), 143. https://doi.org/10.5430/jct.v12n4p143

Archer, R.M., Wagner, M., & Snell, L. (2026). A theoretical framework for experiential learning: Creating Active Knowledge Experiences (CAKE). *Advances in Health Sciences Education*. https://doi.org/10.1007/s10459-026-10508-0

Asagar, M. (2025). Digital Competence in Education: A Comparative

Analysis of Frameworks and Conceptual Foundations. *SSRN Electronic Journal, 2*(1), 9-23. https://doi.org/10.2139/ssrn.5172207

Avidov-Ungar, O. (2025). Empowering Teacher Professionalism Through Personalized Continuing Professional Learning: A Systematic Literature Review Using a Multidimensional Approach to Self-Assessment and Growth. *Education Sciences, 15*(12), 1686. https://doi.org/10.3390/educsci15121686

Bazargani, J., Sadeghi-Niaraki, A., & Choi, S.-M. (2025). A Survey and Framework for Education in the Metaverse. *IEEE Access, 4,* 33231-33245. https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=10892097

Bitar, N., & Davidovich, N. (2024). Transforming Pedagogy: The Digital Revolution in Higher Education. *Education Sciences, 14*(8), 811. https://doi.org/10.3390/educsci14080811

Bou Saad, R., Garcia, A. L., & Garcia, J. M. C. (2025). Mapping Constructivist Active Learning for STEM: Toward Sustainable Education. *Sustainability, 17*(13), 6225. https://doi.org/10.3390/su17136225

Cherner, T., & Fegely, A. (2023). *Bridging the XR Technology-to-Practice Gap: Methods and Strategies for Blending Extended Realities into Classroom Instruction*. Association for the Advancement of Computing in Education

Chigbu, B., & Makapela, S. (2025). AI in education, sustainability, and the future of work: An integrative review of industry 5.0, education 5.0, and work 5.0. *Journal of Open Innovation: Technology, Market, and Complexity, 11*(4), 100645. https://doi.org/10.1016/j.joitmc.2025.100645

Dacholfany, M., Saifi, I., & Sulaiman, S. (2022). Connectivism And Constructivism Approaches To Social Learning Theory. *International Journal of Education, Vocational and Social Science, 1*(1), 1-19.

Dhakal, B. (2023). Digital Pedagogy: An effective Model for 21st Century

Education. *Academic Journal of Mathematics Education, 5*(1), 1-9. https://doi.org/10.3126/ajme.v5i1.54534

Hasim, M., Jabar, J., Isa, N., Vijayakumaran, N. (2025). Exploring the Challenges of E-learning in the Post-Pandemic Educational Landscape: A Qualitative Approach. *International Journal of Academic Research in Progressive Education and Development, 14*(3), 764-776. https://doi.org/10.6007/IJARPED/v14-i3/26066

HyeJin, L., & Yohan, H. (2023). Training with, about, for Metaverse: A Mixed Methods Research on Training Pre-Service Teachers as Metaverse-Certified Practitioners. *Journal of English Teaching through Movies and Media, 24*(4), 73-94. https://doi.org/10.16875/stem.2023.24.4.73

Jindal, P., Jindal, A., & Sharma, D. (2024). Role of Metaverse in the Education Sector. In R. Aggarwal, P. Gupta, S. Singh, & R. Bala (Eds.), *Augmented Reality and the Future of Education Technology* (pp. 215-228). IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3693-3015-9.ch014

Jotania, P., Arya, A., Ashraf, Y., Chavhan, Sh., Singh, U., Nanaware, R. (2021). *Digital Education : Post COVID Era: A research book on digital education after COVID era.* Nexus Stories Publication.

Kabilan, Sh. (2023). Teaching and learning in the metaverse world: The future of new-gen education. *Journal of Engineering Education Transformations, 37*(1), 134-141. https://doi.org/10.16920/jeet/2023/v37i1/23139

Lin, H., Wanm Sh., Gan, W., Chen, J., Chao, H.-Ch. (2022). Metaverse in Education: Vision, Opportunities, and Challenges. Proceedings of 2022 IEEE International Conference on Big Data (pp. 2857-2866). https://doi.ieeecomputersociety.org/10.1109/BigData55660.2022.10021004

Lim, L., Pryor, M., & Beckmann, N. (2025). Social opportunities, learning practices, and performance in metaverse and virtual world: A comparative scoping review in higher education. *Computers &*

Education, 239, 105391. https://doi.org/10.1016/j.compedu.2025.105391

Llanos-Ruiz, D., Abella-García, V., & Ausín-Villaverde, V. (2025). Virtual Reality in Higher Education: A Systematic Review Aligned with the Sustainable Development Goals. *Societies, 15*(9), 251. https://doi.org/10.3390/soc15090251

Matović, S., Marković, T., Dobrosavljević, N., Stajin, M. (2025). Metaverse in education: Teachers' perspectives on benefits and challenges. *Research in Pedagogy, 15*(1), 49-61. https://doi.org/10.5937/IstrPed2501049M

Mena-Guacas, A. F., López-Catalán, L., Bernal-Bravo, C., & Ballesteros-Regaña, C. (2025). Educational Transformation Through Emerging Technologies: Critical Review of Scientific Impact on Learning. *Education Sciences, 15*(3), 368. https://doi.org/10.3390/educsci15030368

Morris, T. H. (2020). Experiential learning – a systematic review and revision of Kolb's model. *Interactive Learning Environments, 28*(8), 1744-5191. https://doi.org/10.1080/10494820.2019.1570279

Muthmainnah, M., Cardoso, L., Marzuki, A.G., Al Yakin, A. (2025). A new innovative metaverse ecosystem: VR-based human interaction enhances EFL learners' transferable skills. *Discover Sustainability, 6*, 156. https://doi.org/10.1007/s43621-025-00913-7

Nagel, I., & Amdam, S. H. (2025). Teachers' Professional Digital Competence. *Encyclopedia, 5*(3), 148. https://doi.org/10.3390/encyclopedia5030148

Parrales-Bravo, F., Tolozano-Benites, R., Jadán-Guerrero, J., Vasquez-Cevallos, L., & Gómez-Rodríguez, V. (2026). From Virtual Worlds to Real-World Equity: A Scoping Review of the Metaverse as Computer-Assisted Learning for STEM Competencies. *Computers, 15*(4), 229. https://doi.org/10.3390/computers15040229

Qian, Y., Wang, J., & Cai, Y. (2023). Revolutionizing educational

landscapes: A systematic review of Metaverse applications, paradigms and emerging technologies. *Cogent Education, 10*(2), 2264006. https://doi.org/10.1080/2331186X.2023.2264006

Reis, I., Peruchini, M., Ulbricht, V., Teixera, J. (2024). The Dilemma of Teacher Training for the Use of the Metaverse and Other Immersive Technologies in Teaching and Learning Processes: An Integrative Review. In: Ł.Tomczyk (ed), *New Media Pedagogy: Research Trends, Methodological Challenges, and Successful Implementations*. NMP 2023. Communications in Computer and Information Science, vol 2130. Springer, Cham. https://doi.org/10.1007/978-3-031-63235-8_7

Rodolico, G., & Hirsu, L. (2023). Virtual Reality in education: supporting new learning experiences by developing self-confidence of Postgraduate Diploma in Education (PGDE) student-teachers. *Educational Media International, 60*(2), 92–108. https://doi.org/10.1080/09523987.2023.2262195

Roy, R., Babakerkhell, M., Mukherjee, S., Pal, D., Funilkul, S. (2023). Development of a Framework for Metaverse in Education: A Systematic Literature Review Approach. IEEE Access, 11, 57717-57734. https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=10144746

Serhieiev, V., Voronina, Y., Zolotov, A., Akimova, L., Rovynska, K., & Akimov, O. (2025). Innovative competences within public administration landscape: sustainable development, financial efficiency and national security strengthening vectors. *Sapienza: International Journal of Interdisciplinary Studies, 6*(1), e25017. https://doi.org/10.51798/sijis.v6i1.947

Shamsudin, N., Hoon, T., Aris, Sh., Yunus, M. (2024). Metaverse Technology for Teacher Training Programmes in Higher Learning Institutions: Perceptions of Teacher Trainees. *Asian Journal of University Education, 20*(3), 717-727. https://doi.org/10.24191/ajue.v20i3.27852

Shumilova, I., Chaliuk, Y., Tonne, O., Akimov, O., & Kobylina, Y. (2026).

Development of public administration in preventive health care: Innovative vectors and world experience. Journal of Management Practices, *Humanities and Social Sciences, 10*(2), 161–176. https://doi.org/10.33152/jmphss-10.2.1

Wijnen-Meijer, M., Brandhuber, T., Schneider, A., Berberat, P.O. (2022). Implementing Kolb´s Experiential Learning Cycle by Linking Real Experience, Case-Based Discussion and Simulation. *Journal of Medical Education and Curricular Development, 9*, 23821205221091511. https://doi.org/10.1177/23821205221091511

Yuliang, J., DeWitt, D., & Razak, R. (2026). *The Application of the Metaverse in Education: Rethinking Learning, Instruction, and Evaluation*. Routledge.

Zamiri, M., & Esmaeili, A. (2024). Strategies, Methods, and Supports for Developing Skills within Learning Communities: A Systematic Review of the Literature. *Administrative Sciences, 14*(9), 231. https://doi.org/10.3390/admsci14090231

Zhang, X., Chen, Y., Hu, L., Wang. Y. (2022). The metaverse in education: Definition, framework, features, potential applications, challenges, and future research topics. *Frontiers in Psychology, 13*, 1016300. https://doi.org/10.3389/fpsyg.2022.1016300

Zou, Y., Kuek, F., Feng, W., Cheng, X. (2025). Digital learning in the 21st century: trends, challenges, and innovations in technology integration. *Frontiers in Education, 10.* https://doi.org/10.3389/feduc.2025.1562391

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