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Developing a Metaverse-Based Learning Environment for High School Students in Ukraine: A Survey-Based Analysis

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Abstract

The metaverse—an interconnected network of immersive, persistent, and interactive virtual worlds—has emerged as a promising paradigm in educational technology. By integrating virtual reality (VR), augmented reality (AR), and Web3-enabled platforms, the metaverse has the potential to reshape secondary education through deeply engaging, experiential, and context-rich learning experiences. This paper presents the findings of a survey-based study conducted with a sample of 120 high school students and 35 educators across various regions of Ukraine. The survey aimed to assess awareness, perceptions, and readiness for metaverse integration in the high school curriculum, as well as to identify potential benefits and barriers. Results reveal strong enthusiasm for metaverse adoption, with 78% of students and 65% of teachers expressing high interest in its educational use. The most commonly cited benefits include heightened student engagement, real-time collaborative opportunities, and the enhancement of STEM and digital literacy skills. However, significant challenges remain, particularly related to high hardware costs, inadequate internet infrastructure, limited teacher training, and concerns regarding data privacy. The paper concludes with strategic recommendations for phased implementation, teacher capacity building, and the development of clear policies to ensure equitable and ethical use of metaverse technologies in Ukrainian high schools.

Keywords: metaverse in education, virtual reality, immersive learning, educational technology

I. Introduction

The rapid evolution of immersive technologies, including virtual reality (VR), augmented reality (AR), and blockchain-enabled Web3 platforms, has given rise to the concept of the metaverse: a persistent, interactive, and highly immersive digital ecosystem in which users can interact with each other and with digital content in real time [1]. In education, the metaverse has attracted considerable attention for its ability to enable experiential learning, replicate real-world environments, and facilitate collaborative problem-solving beyond the constraints of traditional classrooms [2], [3]. These affordances are particularly relevant in high school contexts, where students are at a formative stage in developing both subject-specific competencies and transversal skills such as critical thinking, creativity, and digital literacy.

In Ukraine, the integration of educational technology has been accelerated by a combination of digital transformation policies and the urgent

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need for flexible, resilient learning environments in the face of geopolitical challenges [4]. Disruptions to traditional schooling have highlighted the necessity for innovative solutions that can sustain student engagement, enable continuity of learning, and prepare students for the demands of a rapidly evolving digital society. Against this backdrop, the metaverse presents a compelling opportunity to create immersive, safe, and interactive spaces for both synchronous and asynchronous learning. This study investigates how the metaverse could be effectively developed and implemented in Ukrainian high schools, drawing on survey data from students and educators to identify potential benefits, challenges, and actionable pathways for adoption.

II. Literature Review

A growing body of literature points to the transformative potential of the metaverse in education. Mystakidis [1] characterizes the metaverse as a convergence of physical and virtual realities that supports multi-sensory, interactive learning experiences. Johnson [2] and Lee and Kim [3] emphasize that immersive technologies can improve student motivation and enable active participation in complex problem-solving tasks by simulating real-world contexts. Such environments can be particularly effective in STEM education, where abstract concepts benefit from visual and interactive representations.

However, the integration of metaverse technologies into formal education is not without challenges. Park and Kim [7] warn of privacy and security risks associated with collecting and storing user data in virtual environments. Hanna et al. [8] highlight accessibility concerns, noting that high-performance hardware requirements and internet bandwidth limitations may exacerbate digital divides, particularly in rural or economically disadvantaged areas. In the context of Ukraine, these concerns are amplified by infrastructural disparities between urban and rural regions [10].

Scholars have also identified the metaverse's potential to support education in crisis-affected or post-conflict settings. Miller [9] discusses the role of virtual environments in preserving cultural heritage and enabling remote learning experiences that are otherwise impossible due to safety constraints. Ukraine's ongoing educational digitalization initiatives, combined with its need for innovative remote learning solutions, position the country as a potentially fertile ground for pioneering metaverse-based high school education—provided that technical, financial, and policy-related challenges are addressed.

III. Methodology

To explore readiness and perceptions toward metaverse adoption in Ukrainian high schools, a survey was designed and distributed to a purposive sample of students and educators.

A. Participants

The study engaged a total of 120 high school students, aged between 14 and 17 years, spanning Grades 9 to 11 and representing diverse regions across Ukraine. This demographic distribution ensured that the findings reflected a variety of educational, cultural, and socio-economic contexts within the country. In addition to the student participants, the research included 35 educators, each bringing expertise from a wide spectrum of academic disciplines, including science, technology, engineering, and mathematics (STEM), the humanities, and the arts. Such a multidisciplinary and geographically diverse participant pool provided a comprehensive foundation for analyzing the potential of metaverse technologies in secondary education. The composition of the participants is illustrated in Figure 1.

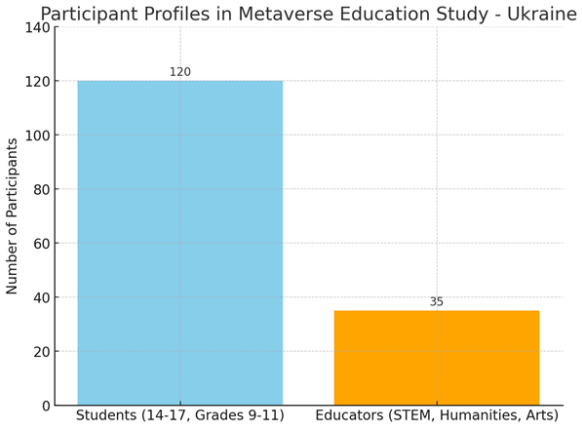

Figure 1: The participant profiles for the Ukraine metaverse education study.

B. Survey Instrument

The survey contained 25 items divided into four sections: (1) awareness of metaverse tech-

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nologies, (2) perceived educational benefits, (3) anticipated challenges, and (4) willingness to adopt. Both closed-ended and open-ended questions were included to capture quantitative data and qualitative insights.

C. Data Collection and Analysis

The survey was administered online over a two-week period in early 2024. Quantitative responses were analyzed using descriptive statistics, while qualitative responses were thematically coded to identify recurring themes in participants' perceptions and concerns.

IV. Results and Discussion

A. Awareness and Interest

The results indicate high levels of awareness of immersive technologies, with 82% of students and 71% of teachers reporting familiarity with VR or AR tools. Interest in applying these tools to educational contexts was also strong, with 78% of students and 65% of teachers indicating high or very high enthusiasm for integrating the metaverse into their learning or teaching practices, as shown in Figure 2.

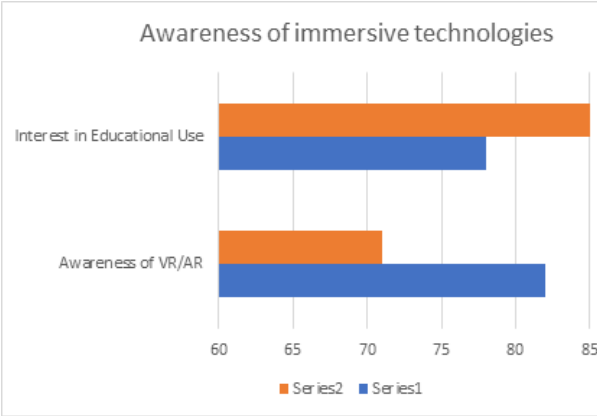

Figure 2: Awareness of immersive technologies

B. Perceived Benefits

Participants identified several potential benefits of metaverse adoption in high school education. The most frequently cited was increased student engagement, noted by 85% of students and 77% of teachers. Other commonly mentioned benefits included improved understanding of STEM concepts (students: 68%, teachers: 74%), enhanced opportunities for cross-school and international collaboration (72% overall), and the development of digital literacy skills essential for future employability, as shown in Table 1.

Table 1: Survey results on perceived benefits of metaverse adoption in high school education

Benefit	Students (%)	Teachers (%)	Overall (%)
Increased student engagement	85	77	—
Improved understanding of STEM concepts	68	74	—
Cross-school & international collaboration	—	—	72
Development of digital literacy skills	—	—	—

C. Challenges Identified

Despite this enthusiasm, participants acknowledged significant barriers to implementation. As shown in Table 2, high hardware costs were cited by 76% of students and 82% of teachers as a primary obstacle. Limited internet bandwidth, particularly in rural areas, was identified by 64% of students and 70% of teachers. Lack of teacher training was noted by 48% of students and 66% of teachers, while privacy and data security concerns were raised by 45% of students and 59% of teachers.

Table 2: Significant barriers to implementation

Challenge	Students (%)	Teachers (%)
High hardware cost	76	82
Limited internet bandwidth	64	70
Lack of training	48	66
Privacy concerns	45	59

D. Discussion

The survey findings suggest that while both students and educators in Ukraine recognize the transformative potential of the metaverse for high school education, significant infrastructural and pedagogical challenges must be addressed before large-scale adoption is feasible. Infrastructure investments, particularly in high-speed internet access and affordable VR/AR devices, are critical. Equally important is the need for teacher professional development programs that focus on both the technical and pedagogical aspects of metaverse integration [11]. Without such initiatives, the benefits of the metaverse risk being

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limited to better-resourced urban schools, thereby exacerbating existing educational inequalities.

V. Conclusion

This study makes a meaningful contribution to the growing body of knowledge on metaverse adoption in high school education by presenting empirical insights derived directly from Ukrainian students and educators. The findings demonstrate high levels of enthusiasm for immersive, interactive learning environments—where both student engagement and conceptual understanding are enhanced, aligning with previous research indicating that VR and AR technologies can significantly boost student motivation and learning outcomes [12][13]. However, integrating metaverse technologies into educational practice is not without its challenges.

Financial and infrastructural obstacles—such as the expense of VR hardware and the need for stable, high-speed internet—remain formidable barriers, especially where equitable access is a concern [13]. These constraints are further complicated by increasingly sophisticated data privacy and surveillance risks associated with immersive learning environments; VR systems frequently capture sensitive biometric data (e.g., eye movements, physiological responses), raising critical ethical considerations [13].

Accordingly, targeted interventions are essential to ensure the metaverse's pedagogical potential is actualized responsibly. These interventions include the development of comprehensive policy frameworks, substantial investments in infrastructure, robust teacher training programs, and the adoption of equitable and privacy-conscious governance models [13]. Only through such context-sensitive, strategically planned efforts can the transformative promise of the metaverse—an engaging, collaborative, and equitable learning experience—be sustainably realized in Ukrainian secondary education.

Future research should focus on the design and implementation of pilot programs in Ukrainian high schools, with an emphasis on evaluating their impact on learning outcomes, student motivation, and teacher workload. In addition, longitudinal studies could provide deeper insights into how sustained metaverse use influences skill development and academic achievement over time. Finally, policymakers should collaborate with educators, technologists, and civil society organizations to develop national guidelines for the ethical, inclusive, and equitable integration of metaverse technologies in education.

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