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SHORT COMMUNICATION

From the physical classroom to the immersive classroom: the metaverse as a socio-technological learning environment

Del aula física al aula inmersiva: el metaverso como escenario socio-tecnológico del aprendizaje

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ABSTRACT

This paper presents an analysis of the metaverse as a socio-technological ecosystem with transformative potential in education, going beyond its understanding as an isolated tool. Based on a critical review of experiences in Spanish-speaking contexts and recent literature, three fundamental dimensions were explored: the design of virtual worlds with pedagogical intent, human-computer interaction, and the interdisciplinary articulation between education, psychology, and technology. It was identified that the effective design of immersive environments must go beyond visual aesthetics, incorporating narrative, collaborative, and affective elements that promote meaningful learning. Interaction with the virtual environment, mediated by intuitive and emotionally sustainable interfaces, was key to sustaining motivation and facilitating complex cognitive processes. It was also highlighted that the incorporation of ethical frameworks, inclusive approaches, and socio-emotional competencies is essential to ensuring equitable and sustainable educational experiences in the metaverse. The evidence showed that this technology fosters skills such as self-regulation, empathy, and critical thinking, provided there is genuine collaboration between teachers, designers, and human development specialists. Finally, it was proposed to understand the metaverse as a space where technological innovation, pedagogical agency, and affectivity converge, capable of responding to the needs of contemporary learning from an integrative and evidence-based perspective.

Keywords: Metaverse; Immersive Education; Human-Computer Interaction; Virtual Worlds; Collaborative Learning; Educational Technology.

RESUMEN

Se presenta un análisis sobre el metaverso como un ecosistema socio-tecnológico con potencial transformador en el ámbito educativo, superando su comprensión como una herramienta aislada. A partir de una revisión crítica de experiencias en contextos hispanohablantes y literatura reciente, se exploraron tres dimensiones fundamentales: el diseño de mundos virtuales con intención pedagógica, la interacción humano-computadora y la articulación interdisciplinaria entre educación, psicología y tecnología. Se identificó que el diseño efectivo de entornos inmersivos debe ir más allá de la estética visual, incorporando elementos narrativos, colaborativos y afectivos que promuevan el aprendizaje significativo. La interacción con el entorno virtual, mediada por interfaces intuitivas y emocionalmente sostenibles, resultó clave para sostener la motivación y facilitar procesos cognitivos complejos. Asimismo, se destacó que la incorporación de marcos éticos, enfoques inclusivos y competencias socioemocionales es esencial para garantizar experiencias educativas equitativas

y sostenibles en el metaverso. Las evidencias mostraron que esta tecnología permite fomentar habilidades como la autorregulación, la empatía y el pensamiento crítico, siempre que exista una colaboración real entre docentes, diseñadores y especialistas en desarrollo humano. Por último, se propuso comprender el metaverso como un espacio donde convergen innovación tecnológica, agencia pedagógica y afectividad, capaz de responder a las necesidades del aprendizaje contemporáneo desde una perspectiva integradora y basada en la evidencia.

Palabras clave: Metaverso; Educación Inmersiva; Interacción Humano-Computadora; Mundos Virtuales; Aprendizaje Colaborativo; Tecnología Educativa.

INTRODUCTION

The metaverse, this three-dimensional space that is not only immersive but also persistent and interactive, is significantly changing how we think about learning today. Its strength lies in its combination of cutting-edge technology and social interactions that feel real, almost tangible. It is not just a pretty platform but an environment that opens up different, new educational possibilities. With virtual reality, avatars, digital objects, and artificial intelligence, this digital universe expands beyond the traditional classroom, offering learning experiences that feel closer, more vivid, meaningful, and participatory.[1,2]

But it is not the same as other digital spaces. There is something more. Unlike the typical virtual realities or online environments we already know, the metaverse has continuity; it does not shut down when you log out. It allows different platforms for people to talk to each other and build together. Hence, it can be considered a stable educational space that does not disappear and allows for more inclusive, more comprehensive proposals.

In this context, education is no longer just about transferring content. It becomes an experience. An experience that touches the senses invites exploration, works with others, and thinks differently. This is achieved thanks to how these virtual worlds are designed, the type of human-computer interaction promoted, and the pedagogical approaches that put the student at the center.[3,4] The pandemic, for its part, accelerated all of this. It pushed many institutions to adopt immersive technologies in response to isolation but highlighted essential challenges and limitations that cannot be ignored.[5,6]

In Latin America, for example, studies show how the educational use of the metaverse can activate multiple intelligences, generate real motivation, and reinforce digital skills from a very early age. Of course, this must be based on a solid pedagogical design grounded in constructivist or collaborative approaches.[7,8] However, there is also a clear gap: the urgent need to better prepare teachers, to offer new methodologies that are appropriate for these environments, and above all, to create strong ethical frameworks that guarantee inclusion, privacy, and respect.[9,10]

Although there is increasing talk about the metaverse in education, some things are still not fully understood. There is a lack of studies explaining how to effectively combine the pedagogical, technological, and emotional. It is, therefore, essential to look at this phenomenon from different disciplines and engage in cross-disciplinary dialogue so as not to be left with a partial or simplistic view.

This work does not attempt to view the metaverse as just another resource or a fad. The proposal goes in another direction. It is about thinking of it as a complex ecosystem where the technical, the affective, and the educational are intertwined. And where the goal is not only to teach but to design experiences that transform and connect with the learner. The approach presented here combines pedagogy, psychology, and technology to understand how far the metaverse can go as an educational space.

DEVELOPMENT

Talking about the metaverse as a learning environment is insufficient to describe its appearance or technological promises. To truly understand its educational scope, it is necessary to break down the elements that make it up from within: how its worlds are designed, how people interact with these environments, and what pedagogical or psychological principles underpin its functioning. It is not just a matter of "entering" a virtual space but of asking what happens when someone learns, teaches, or connects with others. In this sense, this paper is organized around three key dimensions that allow us to think of the metaverse as a complex educational ecosystem: designing virtual worlds with pedagogical purposes, human-computer interaction as meaningful mediation, and the dialogue between education, technology, and psychology. Through these axes, we seek to identify both the opportunities and tensions that emerge when the digital ceases to be a peripheral resource and moves to the center of the educational experience.

Designing virtual worlds for educational purposes

Designing virtual worlds for educational contexts should not be limited to copying the appearance of a

classroom or physical environment. That is only the beginning. What is really important is that the design is guided by clear, meaningful pedagogical intentions that aim to generate learning that truly sticks, encourages collaboration, and allows students to learn independently and at their own pace. These immersive digital platforms, such as OpenSim, Second Life, or 3D graphics engines, not only allow for the construction of eye-catching scenarios but also make it possible to develop multisensory spaces where students move, act, and make decisions. They are not just watching. They participate, converse, and transform what they see.[11]

One of the aspects that makes the most significant difference in this type of environment is how the narrative, affective, and collaborative components are intertwined. These are not decorative additions; they bring the experience to life. They are elements that help users feel part of that world, recognize themselves within it, and want to stay and explore. In Latin America, experiences have been documented where the use of personalized avatars, game mechanics, objects that can be manipulated, and tasks with a well-defined educational purpose have generated higher levels of motivation, a sense of agency, and active permanence in these spaces.[12,13] All of this works best when based on theories such as constructivism or connectivism, which give the student a central, active role. So, the virtual world is not just a stage set; it becomes a place where learning is creating, interacting, trying, and even making mistakes.

Some experiences illustrate this concretely—for example, the Innova-T3D project at Uniminuto in Colombia. There, an immersive virtual campus was built that connected what already existed on e-learning platforms with 3D environments. It was not just something visually novel. According to the results, collaborative work among students was strengthened. It led to a deeper, more contextualized appropriation of knowledge, thanks to direct interaction with objects, spaces, and dynamics that felt real.[14]

In another case, researchers at the University of Cundinamarca tested a teaching guide that integrated virtual worlds into the classroom. The key was to foster creativity and improve interaction between teachers and students. The result was positive: not only was collaborative learning stimulated, but those who participated considered the helpful tool, practical, and easy to use, which is no small feat regarding educational technologies.[15]

So, designing virtual worlds for educational purposes requires a dual perspective: technical and pedagogical. It is not enough for them to be functional, usable, or customizable, nor is it enough for them to look good. They need to have a solid pedagogical intention behind them, one that allows for creating active, emotionally meaningful experiences that leave a lasting impression.

However, it is one thing to design well-thought-out virtual worlds and quite another to experience them. Learning in the metaverse also depends, to a large extent, on how people interact with that digital environment. How you navigate, feel, and perceive, and how easy or complex it is to move around and connect with what is there. This brings us to a central aspect: human-computer interaction. Because we do not learn only with our eyes or through passive observation. We know by touching, making mistakes, and connecting with what the space offers. Much more is at stake in this relationship between the user and the environment than technical access. It also defines how the experience is lived and interpreted and how much the act of learning itself can be enjoyed.

Human-computer interaction in the metaverse

The real impact of the metaverse on education does not depend solely on its existence as a space but on how the link between the person and that environment is constructed. In other words, it has much to do with the type of interface used and how that human-computer interaction, or HCI, is designed and managed. It is not just about accessing the virtual space, being able to enter or move around within it. What matters is how that contact shapes the experience: how the environment is perceived, how what is happening inside is understood, and how an emotional relationship is generated between the user, the digital objects, and the other people present.

One of the significant contributions of HCI in these contexts is its ability to generate experiences that are not only interactive but also appeal to the senses and emotions. Models such as Extended User Experience, or UxE, help integrate different dimensions into the design: the aesthetic, the functional, and the affective. This allows the experience to be valued not only from a technical point of view but also in terms of enjoyment, motivation, and the level of satisfaction that being there, inside the metaverse, can produce.[16] This emotional dimension becomes key to sustaining their attention and commitment in prolonged scenarios where students remain immersed for extended periods.

Various studies in Latin American universities have shown that when navigation is fluid, the interface is intuitive, and the environment feels real, the perception of learning improves. This was the case at the Virtual Campus of the University of Nariño, where the UxE model was validated, and the results reflected a high degree of technological acceptance and intrinsic motivation on the part of the students.[17] Similarly, at the IXTLI laboratory at the National Autonomous University of Mexico (UNAM), which has developed more than 150 educational projects using immersive virtual reality, progress has been made in understanding abstract

concepts through the direct manipulation of 3D objects, which has been highly valued in terms of meaningful learning.[18]

The social dimension of learning also involves this type of interaction. Designing spaces that allow collaboration and voice communication and using avatars with gestures and objects that respond to human actions helps reinforce the feeling of being together in the same place. Digital co-presence is not just an illusion; it is an experience that can feel very real and reconstitutes the human side of online learning.[19,20] User-centered design is not limited to making the environment more straightforward to use. It also opens the door to lasting bonds and connections between people who are not physically close but are emotionally involved.

Additionally, when design is approached from an HCI perspective, it becomes easier to address issues of accessibility and inclusion, which are not always considered. Adaptive interfaces, voice commands, and augmented visualizations are some resources that can facilitate the participation of students with different abilities. Not everyone accesses the environment in the same way, but everyone should be able to do so on equal terms.[21]

Last but not least, it has been documented that technology-mediated interaction in forums, simulators, or problem-based environments helps strengthen fundamental skills such as self-regulation, empathy, and collaboration. These skills are key, especially in situated learning, where what is learned has immediate practical meaning and explicit social value.[22,23,31]

Interdisciplinary perspective: education, psychology, and technology

To truly understand the educational potential of the metaverse, it is not enough to look at it solely from a technological or pedagogical perspective. We need a view that combines knowledge, integrates disciplines, and allows us to see the phenomenon in all its complexity. The intersection between education, psychology, and technology offers precisely this broader approach. Not only does it help to create attractive, technically well-designed virtual environments, but it also allows for emotionally meaningful experiences and represents a real cognitive challenge.

From an educational psychology perspective, the metaverse is a clear opportunity to foster self-regulated learning, internal motivation, and emotional engagement. However, not just any experience can achieve this. They need to be well-designed and touch the student's affective and cognitive sides in a balanced way.[24] When that connection is completed, even if managed carefully, negative emotions can become a learning resource: they help develop empathy, moral judgment, and decision-making skills.[25] It is not about avoiding discomfort but about learning to navigate it.

That is why theories such as emotional intelligence and positive psychology offer beneficial frameworks for designing educational experiences in the metaverse that are not emotionally fragile and can be sustained over time without overwhelming the user. In countries such as Costa Rica and Spain, intervention programs have been documented that combine disciplinary content, digital tools, and social-emotional skills, achieving deeper learning that students can apply in different contexts.[26,27] These are not anecdotal results but signs that the interdisciplinary approach works.

From a technological standpoint, this articulation allows for incorporating concepts such as instructional design, cognitive ergonomics, and emotional engineering. All of these help to build more innovative immersive environments, so to speak. Environments that look good and activate complex mental processes stimulate neuroplasticity, invite critical thinking, and spark creativity. Examples such as the use of contemporary art in physical education classes or the design of enriched environments show that what surrounds students—the space itself—can influence their behavior, interaction, and motivation to learn.[28,29]

For its part, pedagogy continues to be the foundation that gives meaning to all of this. From there, an ethical and methodological framework can be established to prevent these technologies from ending up as mere tools or digital embellishments. The role of the teacher also changes in this context. They are no longer just transmitters of knowledge. They become designers of experiences, emotional companions, and content curators within digital worlds that require a different logic. And this, of course, involves working with professionals in psychology, HCI, and human development.[30]

In short, when education, psychology, and technology are coherently articulated, the possibility of designing richer, more ethical, and more inclusive educational experiences opens up. These experiences respond to the demands of the present and are better prepared to face the complexity of learning in the contemporary world.

CONCLUSIONS

The metaverse does not simply represent a technological evolution applied to education. Rather, it represents a profound change in how learning is conceived, integrating cognitive, emotional, social, and ethical dimensions into complex digital environments. Throughout this essay, it has been argued that its true educational value does not lie in the novelty of its platforms but in its ability to generate immersive experiences that connect with learners' needs and unique characteristics.

The design of virtual worlds with pedagogical intent, the quality of human-computer interaction, and an interdisciplinary approach are elements that, when coherently articulated, enable the construction of more prosperous, more active, and more sustainable learning ecosystems. The evidence reviewed showed that the metaverse can promote autonomous exploration, collaborative work, emotional self-regulation, and critical thinking, providing a solid methodological basis and an ethical commitment to its implementation.

However, significant challenges remain. Progress is needed in teacher training, rethinking curriculum frameworks, and promoting an institutional culture that values pedagogical experimentation. Likewise, it is essential to guarantee inclusion, accessibility, and personal data protection as basic conditions for any immersive educational proposal.

Ultimately, the metaverse must be understood as a space of possibilities, not a closed solution. Its contribution to education will ultimately depend on how it is integrated into person-centered teaching and learning processes guided by humanistic principles and oriented toward comprehensive development. Metaverse does not simply represent a technological evolution applied to education. Instead, it means a profound change in how learning is conceived, integrating cognitive, emotional, social, and ethical dimensions into complex digital environments. Throughout this essay, it has been argued that its actual educational value does not lie in the novelty of its platforms but in its ability to generate immersive experiences that connect with learners' needs and unique characteristics.

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