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Current possibilities and challenges of using metaverse-like environments and technologies in education

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This paper presents findings from a stakeholder mapping exercise exploring how higher education professionals perceive and engage with metaverse-like environments and technologies. Based on 20 in-depth, semi-structured interviews with higher education professionals, the research investigates both the perceived opportunities and challenges associated with implementing metaverse-related tools in academic contexts. The results present various viewpoints: while some participants highlight that these environments are valuable for experiential learning, others mention such barriers as institutional limitations and insufficient technological infrastructure. The study contributes to the discussion on the role of virtual environments in higher education, emphasizing the importance of strategic support and pedagogical alignment for meaningful integration.

KEYWORDS

metaverse, education, virtual worlds, pedagogy, experiential learning

1 Introduction

The concept of 'Metaverse' offered a ground of speculation since it acquired its initial hype in October 2021 with Mark Zuckerberg's statement about creating Meta and its own social VR space. An often-quoted definition of the metaverse is by Matthew Ball (2022), according to whom the metaverse is: "A massively scaled and interoperable network of realtime rendered 3D virtual worlds that can be experienced synchronously and persistently by an effectively unlimited number of users with an individual sense of presence, and with continuity of data, such as identity, history, entitlements, objects, communications, and payments." While there is no established consensus concerning what the concept of metaverse(s) might mean, there appeared a multitude of opinions and many whitepapers addressing the issue, as it seemed to many that digital or virtual worlds will be affecting many aspects of our life, including economy, industry, and governance. For instance, many EU strategies have already addressed the anticipated transitions (An EU Initiative on Virtual Worlds: A Head Start in the next Technological Transition, 2023), the industrial relatedness and also citizens' recommendations about the directions of developing the virtual worlds (Staff Working Document, 2023), and various industry whitepapers looked more closely into how digital ethics can manifest in the metaverse (Chi et al., 2023; Arunov and Scholz, 2023) or into what shape these spaces will take in the future and how they can provide a space for democracy (Anderson and Lee, 2023). On the other

hand, many of these whitepapers do not focus on how the various stakeholders consider the role of education in the metaverse-like environments in the frame of higher education. As new technologies are more widely used in education, and because interactive technologies are connected to the notion of the metaverse, it is important to uncover the current state of the real and imagined potentials of these tools in facilitating higher educational institutions.

In this study, we aim to explore how current educational and research professionals who work in the area of VR, immersive storytelling, psychology, and technology see the effect of metaverse on education or educational research and the speculations surrounding the issue. The main contribution of this study lies in its comprehensive mapping of the current landscape of metaverse technologies as perceived by professionals in higher education, revealing significant barriers to integration. The need for enhanced collaboration between academia and technology enablers in order to underscore the potential for educational institutions to actively participate in developing metaverse-related curricula that foster experiential learning and critical thinking.

In order to understand this, we analyzed 20 interviews from a wider qualitative study conducted by Goethe-Institut. The aim is to understand globally the influence of interconnectedness on culture and education and to introduce new approaches to facilitate cultural and educational activities by utilizing the affordances of these technologies. The Goethe-Institut identified, contacted and interviewed the participants of the study.

Despite the diverse perspectives on the metaverse and its educational potential expressed by policymakers, technologists, and strategists, there remains a significant research gap regarding how education professionals understand and utilize these technologies in their daily practice. Specifically, it is essential to explore what educators perceive as the benefits and challenges of integrating metaverse technologies into future learning environments. Our study was guided by the following questions: What significance does the metaverse currently have for cultural and educational institutions? How relevant is it for them in terms of how it impacts their pedagogical practices (e.g., do they have to change the expected learning outcomes)? What potential does the metaverse offer cultural and educational institutions for engaging with audiences or students? To what extent can they adapt to the recent trends? What are the various types of constraints or dangers that they encounter during possible use cases in education or research activities?

As metaverse-related technologies become extremely ubiquitous, our aim is to map the opportunities and the challenges of using or experimenting with metaverse-like environments or virtual worlds in education. Our study aims to serve as a springboard for the development of educational platforms or social virtual worlds and to offer specific key points for the designers of such platforms. To this end, the conducted interviews with professionals from the field of education and research will help us to explore the following research questions:

RQ1: How do educational professionals define (the) metaverse(s) as an emerging trend that affects their work and how do they situate it as potential users considering its actual or future use?

RQ2: What are the specific pedagogical affordances that technologies related to the 'metaverse' provide?

RQ3: What are the possible behavioural effects caused by metaverse-related technologies on education?

2 Background literature

2.1 The metaverse(s)

Before some of the well-known occurrences of the concept of a metaverse, such as in Neal Stephenson's famous novel *Snowcrash* (1996), researchers from informatics and computer science have already been referring to the concept. This early engagement with the concept set the stage for more structured explorations of metaversal futures. In 2006, the Metaverse Roadmap Summit held by the Stanford Research Institute International created scenarios concerning metaversal futures centered around two key continua, augmented-simulated and external-intimate. They mentioned Augmented Reality, Lifelogging, Mirror Worlds and Virtual Worlds as four major scenarios for the metaverse (see Figure 1), which can still be encountered in recent literature (Smart et al., 2006). Virtual worlds increasingly augment the economic and social life of physical world communities, while mirror worlds serve as informationally-enhanced virtual models or "reflections" of the physical world. Augmented reality utilizes metaverse-related technologies to enhance the external physical world for individuals through location-aware systems and layered networked information. Lifelogging employs augmentation technologies to record and report the intimate states and life histories of objects and users, supporting object- and self-memory, observation, communication, and behavior modeling. Among these four scenarios, the concept of Virtual Worlds emerged as the dominant understanding of the metaverse during the COVID-19 pandemic (Kye et al., 2021, 6), although in 2009 (Davis et al., 2009, 91) had already defined metaverses as "immersive three-dimensional virtual worlds (VWs) in which people interact as avatars with each other and with software agents, using the

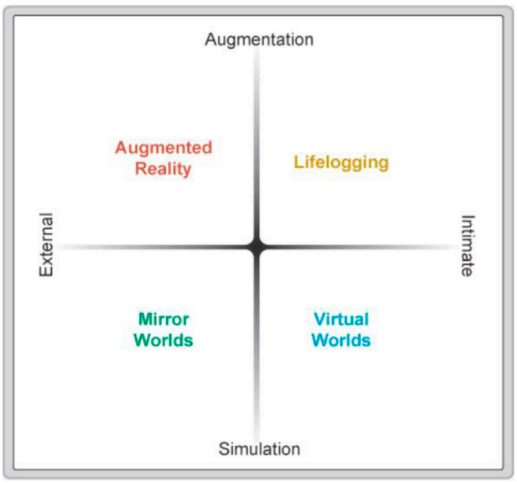

FIGURE 1
A diagram of the four types of scenarios according to metaverse roadmap summit 2006 (Smart et al., 2006).

metaphor of the real world but without its physical limitations" and which enables teams to overcome geographical or other types of challenges for collaboration.

According to Go et al. (2021) the metaverse is "a 3D-based virtual reality in which daily activities and economic life are conducted through avatars representing the real themselves." (Translated to English and cited in Kye et al., 2021), while Lee et al. (2021) define it as "a world in which virtual and reality interact and co-evolve, and social, economic, and cultural activities are carried out in it to create value."

As one can see, all of these definitions suggest that metaverse(s) are virtual worlds that can often connect users either by connecting their physical and digital life or help them overcome various challenges to collaboratively conduct various activities and create value as well. Mark Zuckerberg listed eight fundamental building blocks that metaverse should be constituted by: 1. Feeling of presence; 2. Avatars; 3. Personal space (home space); 4. Teleportation; 5. Interoperability; 6. Privacy and safety; 7. "Virtual good"; 8. Natural interfaces (Zuckerberg, 2021). These notions represent a technological approach to describe the characteristics of the notion and of the affordances of the metaverse and its related technologies. In the current study, we will also map what professionals mean by the metaverse and how they perceive the educational challenges. As we identified the concept of "metaverse" as not one single virtual world, but a broad concept that covers many approaches, in this study we will use it in its generic form, written as "metaverse" without capital letters. In this paper, we utilize the concept of the metaverse as a network of interconnected virtual worlds that integrate physical and digital realities. This integration allows users to interact through avatars in immersive environments, creating a collective virtual shared space. The metaverse operates with emerging technologies, including artificial intelligence and extended reality (AR/VR/MR), to enhance user experiences when interacting with each other and with dynamic, computer-generated environments.

2.2 Education in the metaverse(s)

Value-creation can be manifested through personal meetings and also educational activities that involve a sense of togetherness. This sense of togetherness, even though differing from the physical learning environments, enable social VR experiences suitable for educational activities (Gunkel et al., 2018). There are several reviews that aim to map how the metaverse can contribute to various educational activities, but due to the indecisive usage of the term, these reviews usually offer a broader view reflecting the broad understanding of the researchers. In their systematic review, Tlili et al. (2022) outline articles that approach the question of education and metaverse in the framework of the Metaverse Roadmap Summit scenario, and they identify three waves that the publications thematize: social aspect, the potentials of technology-mediated presence and immersive technologies, and "self-organized AI-powered virtual learning ecologies." The authors conclude that the metaverse is not a new technology, but has been here with us for 2 decades in various forms (Tlili et al., 2022, 11), and they also claim that the threats of the technology are not mapped in the current literature, only the possibilities are described. Currently, there is a significant gap in empirical data regarding the number of organizations utilizing metaverse-related technologies. While a metaverse adoption framework for educational purposes has been published (see Maghaydah et al., 2024), a comprehensive understanding of the factors influencing user engagement and acceptance remains elusive (Al-kfairy et al., 2024) however there is a growing number of studies that look at particular use-cases of the technologies in the area of education.

Metaverse-like environments foster high user engagement and strong intentions for learning, particularly due to its narrative-driven and interactive nature, though it requires improvements in technological aspects and ease of use to fully realize its potential in enhancing educational outcomes. Metaverse-like environments manifested in VR can actually be useful for language learners (Thrasher, 2023), where a pedagogical approach that incorporates game mechanics and gamification can create an immersive and participatory context for developing language competences (Wu et al., 2024). According to Tlili et al. (ibid.), within the broader sense that they frame the metaverse, the subject matters that are taught are mainly related to natural sciences, mathematics, and engineering (53%), and to a lesser extent concern general education (15%) and arts and humanities (11%). Discussing the relation of metaverse and education, Kye et al. (2021) draw our attention to the fact that we still need to analyze students' understanding of and demands from the metaverse, and also its effectiveness and attractiveness, while the instructors should also gain a deeper understanding of the platform's possibilities and pitfalls. They also point out the need to develop an educational platform that prevents the misuse of students' data as in the digital world personal data is more often "organization-centric" and not "user-centric" (ibid.). Several studies show that VR-based use cases of the metaverse-like environments are very suitable for specific trainings, such as aviation training (Fussell and Truong, 2020) and maritime training (Renganayagalu et al., 2022). It is also a suitable tool for teaching soft skills and training for arts and humanities (Tlili et al., 2022, 22). The metaverse, understood as virtual worlds, can be fully accessed and experienced in its immersive capacities mainly by VR headsets. The tools that enable users to enter immersive virtual worlds can be used for instructional or interventional purposes (European Commission, 2023), and therefore can allow the application of these technologies for education, from school education up until in-company education.

2.3 Barriers of integrating metaverse-related technologies into education

Research on the integration of technology into learning situations shows similar patterns in many respects across different educational settings and different versions of digital technology (Butler and Sellbom, 2002; Johnson et al., 2016; Wood et al., 2005). Despite their growing importance (Onu et al., 2023), educational institutions, as in the past, face a number of challenges in integrating the metaverse (Tlili et al., 2022). These challenges are typically organized around the following themes, as identified in the majority of studies:

1. Costs and infrastructure: The implementation of metaverse technologies requires significant investments in hardware (e.g., VR headsets, computers) and software, as well as a strong internet infrastructure, which is not feasible for all institutions (Zhang et al., 2022).
2. Digital divide: Not all students have the tools or internet speed to participate in metaverse education, exacerbating inequalities in access to technology (Haque et al., 2023).
3. Technical skills and training: Accessibility difficulties also mean that neither teachers nor students have the technical skills needed to navigate in metaverse environments, so adequate training and support are critical. Teachers are reluctant to invest time in learning new technologies, especially if they do not see them as having immediate relevance to their teaching goals. They also highlight the lack of personalized training to tailor technology to their specific disciplinary needs, which makes learning technology unconnected to academic content (Butler and Sellbom, 2002). Studies typically articulate the importance of institutional support, but several also emphasize the primary role of systemic support and training (Butler and Sellbom, 2002; Johnson et al., 2016). Wood et al. (2005) extend this idea by emphasizing the role of teacher trust and that emotional support and psychological preparation can influence how well teachers adopt new technologies.
4. Privacy and security, ethical considerations: As metaverse platforms collect huge amounts of personal and behavioral data, privacy and cybersecurity concerns are significant, especially in educational contexts. While educational metaverses can create a new and more dynamic learning environment, they require a certain level of oversight to ensure that they are safe for both students and educators (Onu et al., 2023).
5. Psychological burden: When using the metaverse, students tend to get lost in the virtual world due to sensory technologies, which can lead to addiction and health problems (Xi et al., 2022). In this context, the guidance of teachers and parents becomes essential to help young people navigate a healthy balance between virtual and real-time experiences. The formation of digital identities may blur the line between real and virtual selves, while excessive virtual social interactions can make real interactions more difficult. Therefore, it is important that society and family support students in distinguishing and managing reality and the metaverse (Zhang et al., 2022).
6. Pedagogical integration: The metaverse should be integrated into the curriculum in a meaningful way that improves learning outcomes, and not merely as a novelty or a substitute for effective teaching methods. Educators need to adopt new teaching strategies to effectively use immersive experiences without compromising educational goals (Haque et al., 2023). Many educators are unsure of the real value of using technology in teaching. They often question whether the effort required to learn and implement new tools is justified, especially when the link between technology and improved student learning outcomes is not clear (Butler and Sellbom, 2002). However is also important to mention how young students can be more susceptible to digital contents also because of a less developed cognitive control system (Siste et al., 2021). therefore when developing educational content this perspective should also be taken into consideration.

According to the European Commission's report on XR technologies (European Commission, 2023) the XR technologies can serve as "aims of intervention" recognizing diverse use cases and offering new pathways to accessing information and developing skills. The affordances listed in the table highlight how the media specificities of XR can support innovative educational methods—not only through advanced visualization capabilities but also through its experiential dimension, such as enabling virtual travel and immersive storytelling.

Generative AI also offers new perspectives on educational strategies in metaverse environments. Yu (2023) proposes an adaptive AI-driven learning system for English language learning tasks that integrates VR. While the tool demonstrates significant educational potential, it is still highly costly development phase, with varying levels of technology-readiness that require further research to address challenges in large-scale implementation. According to Almeman et al. (2025) the AI-driven metaverse is being applied in various educational disciplines as it enhances student engagement. The main fields include medical education, engineering, and language learning, with potential for expansion into fields like history and environmental studies. However any long-term impact cannot yet be assessed as "current AI models are not yet specifically designed for such complex, interactive, and immersive virtual environments" (Almeman et al., 2025) due to computational, hardware and other technical problems, as well as ethical security concerns.

As described above, the concept of the metaverse has evolved over time, allowing theorists and practitioners to offer various definitions. This multiplicity of definitions presents a challenge for researchers and policymakers in education, as they must not only define the metaverse for themselves but also identify appropriate educational purposes and sustainable use cases. For the purpose of this study, we took into consideration the metaverse-related definitions, the educational and artistic potential, the embodiment and sense-related codes as well as the answers that refer to familiar anchors and new paradigms, in terms of what these technologies can bring into education. The study aims to fill this research gap by mapping the understanding of educational and cultural professionals regarding the metaverse, exploring the affordances that enable them to utilize related technologies, and examining their perspectives on the future of these technologies in creating novel educational methodologies.

3 Methodology

3.1 Participants

The qualitative study was conducted by the Goethe Institute between December 2022 and March 2023, via 41 in-depth semi-structured interviews with international professionals working in established cultural and educational institutions or VR-related companies. The interview study was prepared as part of the *GoetheVRsum* program. The participants were recruited through snowball sampling (Parker et al., 2019). However, this was also

combined with targeted recruitment strategies to ensure a more balanced representation of academics across different regions. This involved reaching out to academic networks beyond Germany to include participants from diverse backgrounds. The participants of the interview study were working either as artists, creators, production managers, or at higher educational institutes which was made possible with stratified sampling approach to ensure that the sample is representative of various academic disciplines and geographical locations (see Figure 2).

In the current study, we analyzed the interviews made with 20 of the participants who either worked as researchers, educators, or in other creative or strategic roles at such higher educational institutions. Participant selection was informed by the demographic data supplied by the interviewees. They were selected based on their expertise in interactive technologies or VR, scientific publications, or policy-making activities related to metaverse-related technologies. We aimed to map their views on how higher education institutions aim to use these technologies in their curricula, what are the possible scenarios and how the metaverse affects the future of education.

3.2 Interviews

The interviews lasted between 40 and 60 min and took place online using conference call tools to record the audio of the interviews 11 of the interviews were conducted in German language, and the others in English. The transcribed interviews are available upon request. The semi-structured in-depth interview format allowed the interviewees to deep-dive into specific topics, and the interviews always touched upon the following questions: How do participants define the term "metaverse"? What feelings does the concept of the metaverse evoke for them? What motivates them to engage with the metaverse? How do they perceive sustainability in metaverse interactions from social and ecological perspectives? Do they think the metaverse complements physical events, or does it serve as a substitute? Should cultural and educational institutions provide alternatives to profit-driven tech offerings? How do institutions manage the significant costs associated with developing or maintaining virtual environments? Can they identify application scenarios in the metaverse that promise real added value? What technical advancements do they believe are necessary to facilitate a shift toward more inclusive virtual environments? What social debates do they think could be addressed or initiated through technologies associated with the metaverse?

Number	Position	Country	Gender
P1	professor	Norway	Male
P2	coordinator	Germany	Male
P3	coordinator	Germany	Male
P4	professor	Germany	Male
P5	professor	Germany	Male
P6	professor	Germany	Male
P7	researcher	Germany	Female
P8	coordinator	Germany	Female
P9	researcher	Germany	Female
P10	researcher	Germany	Female
P11	coordinator	Ecuador	Female
P12	professor	Israel	Female
P13	professor	Hong Kong	Female
P14	lecturer	The Netherlands	Female
P15	professor	Peru	Male
P16	coordinator	US	Male
P17	coordinator	non-disclosed	Female
P18	professor	Germany	Male
P19	professor	US	Male
P20	professor	US	Female

FIGURE 2
European Commission's report taxonomy on the XR affordances that can be used in education.

3.3 Analysis

We conducted thematic analysis on the data using Braun and Clarke, (2022). The inductive way of conducting reflexive thematic analysis, as described in the method, allows identifying themes from the data, capturing participants' subjective experience and supports analyzing emerging digital experiences and practices.

The German interviews were translated into English and checked back after establishing the codes. Thematic analysis allowed the researchers to identify themes from the data, capturing participants' subjective experiences and helped with analyzing emerging digital experiences and practices such as those related to using metaverse-related technologies in education. First, the interviews were read by two members of the research team depending on their language knowledge, coding them for important information related to the study research questions. The two members who conducted the analysis, compared the themes, with any discrepancies being discussed and themes being renamed or reconsidered. This process allowed them to maintain a recursive cycle of familiarization, coding, and theme generation, in which the researchers continually reflected on their own assumptions and perspectives while engaging with the data. As this involves the researchers to actively participate in interpretation reflexive thematic analysis is not designed to be strictly replicable, as there is no fixed coding frame. Codes that represented similar concepts across different interviews were synthesized into themes, such as the variety of aspects around the concept of metaverse, the technological characteristics that allow them to be used in education, and how these various characteristics, such as embodiment and simulation, can motivate us to rethink education in metaverse-like environments. Based on this discussion, the four themes agreed upon by both investigators were finalized (see Section 4) and the design directions were defined by both of them.

4 Results

Based on our analysis we identified the codes which we grouped into the following code groups: technological and sociological definitions, the spectrum of interactivity, accessibility, the metaverse-like environments' effects on the sole individual, transparency and value-orientedness, educational and artistic potential as well as embodiment and multisensoriality, familiar anchors and new

paradigms (see Figure 3). This paper does not focus on the specific methods of utilizing metaverses in education, such as lectures or student tasks. Instead, it maps the perspectives on the potential opportunities and barriers that exist within virtual worlds for educational purposes.

4.1 Future is not what it used to be: understanding the metaverse and its shortcomings in education

Thematic analysis revealed that participants perceive metaverse-related technologies as evolving and ambiguous ("fluid concepts," "unmapped potentials"), with key affordances such as embodiment, simulation, and safe spaces enabling immersive and identity-sensitive learning environments. However, significant barriers—coded as experiential disconnects, challenges in social competence development, and declining learner motivation—limit the effective deployment of these technologies in educational settings.

4.1.1 Technologies

Professionals working in higher educational institutions who use new technologies (or technologies related to the metaverse such as VR or AR) often differ in their understanding of what metaverse means. P3 stated that metaverse "is a bit like the extended reality-mode, but real". Similarly, P1 thinks that the metaverse is a "fluid concept", while P11 and P18 mentioned that the metaverse is the (new) Internet. P9 suggested that the term 'media sphere' should be used for metaverses. According to many of the participants, we do not fully grasp the potential of these technologies, but many of them note how the metaverse is connecting the physical reality with the virtual, and often quote Matthew Ball's definition as well (e.g., P19, P20). When discussing the related technologies, the participants mention mainly VR (P5, P11, P16), AR (P8, P15) as well as the development of mobile applications (P7). Only P1 mentioned more in-depth technical algorithms that can be used in the metaverse, namely, the blockchain, although P20 also emphasized several times the economical dimension of the metaverse. However, many

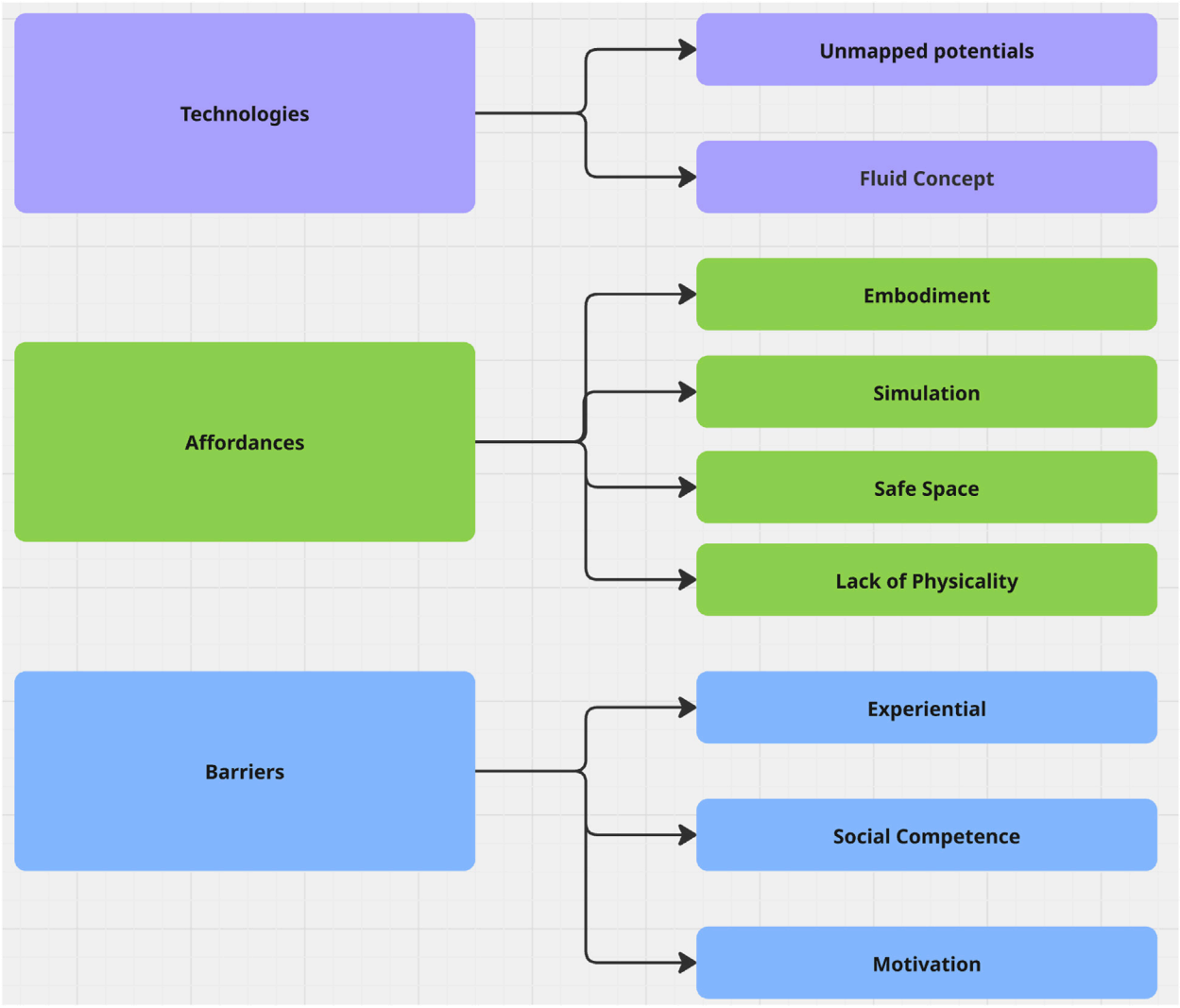

FIGURE 3
The list of the interview study participants.

participants mentioned that the metaverse itself is not here yet (e.g., P1), "not yet fully social" (P20) or that the potentials of the metaverse "are unknown yet" (P9). Some participants also expressed their concerns about data protection (P8) as many of these tools can record data about the user. These challenges can be attributed to factors such as hardware and technological constraints, as well as insufficient interoperability.

4.1.2 Affordances

Several participants have mentioned particular characteristics of metaverses, namely, simulation and embodiment. Regarding simulation, participants views were diverse: while P7 questioned the pedagogical value of consistently using 'fantasy-worlds' to teach real-world scenario-based skills for the students, similarly to P4 who emphasizes that real-world situations and their re-enactment can offer authentic learning experiences, many other professionals emphasized how important it is to create imagination-based worlds (P8, P15). The simulation aspect of the metaverse-like environments can also be approached from the notion of 'spatiality'. P19 mentioned that metaverse means moving from 2-dimensional space to three dimensions. Spatiality is also emphasized by P2 who described how learning in 3D and experimenting with new physicalities (e.g., folding shapes in VR) could be important assets, but also pointed out the importance of preparing the students to not to confuse virtuality with the reality (P11) meaning that the rules and mechanics valid in virtual environments do not always apply to the physical world.

P9 mentioned that "technology is embodied knowledge," meaning that corporeality (meaning that the virtual worlds aim to replicate aspects of our bodily existence) and embodiment is a very important characteristic of being in a virtual world in the form of an avatar. They allow not only practicing interactions or simulating situations in various types of trainings, but they can also make getting in touch with each other in social virtual spaces much easier. P12 acknowledged that the appearances are not hindering us to reach out. Similarly, P11 mentions that these virtual worlds are suitable for "representing marginalized groups and their feelings." However, according to P9 the metaverse will by no means replace real contact, "because we simply do not have a smell, and micro-movements are also difficult to recognize."

This special embodiment, which is mainly manifested by visual and auditory input, creates the need of the participants to be offered a safe space (P11), where they can also assess how to present their digital identity and how to deal with anonymity in an ethical way (P14, P17). According to P9, one can ask questions of how conscious are those creators who develop VR technologies: this points to a co-evolution between humans and technology, while P11 emphasizes how individuals have to understand that one should not confuse parallel worlds with parallel identities. As the interviews were made before the hype-cycle of AI-generated contents, the participants of the study were not referring to these technologies (e.g., deep learning, computer vision).

4.2 Barriers of deploying the affordances of metaverse and related technologies in education

According to P4, these technologies enable simulations that reenact possible and real scenarios and they give way to an opportunity for authentic learning experiences. There is a deviation between the expectations of the students and of the teachers, therefore the experiential turn in education is being addressed more as a possible innovative aspect while more and more people are acknowledging that "it is not here yet" mainly due to technical limitations. The lack of technical personnel in schools who can deal promptly with these new technologies is also missing (P10), therefore the inclusion of these technologies in the curricula is not consistent. On the one hand, for some educators–leaving aside the technical difficulties–metaverse promises joyful situations to interact with virtual characters (P20) that can often have surprising outfits. On the other hand, assessing the students' knowledge is a challenge, as there can be a huge gap between what the students really learned, and what they feel that they learned (P20). While togetherness is an important asset of the social virtual worlds, according to P10 developing social competence in the metaverse is still a question; this is also because young users have more difficulties understanding each other's emotional facial expressions (P9), although according to P12 it is hard to believe that "people can just watch lectures and can learn also by experiences, which further enhances the power of the promises of these technologies." It is important to recognize that there is no generalized answer to various educational methodological challenges, and one always has to look at the given objectives (P7). The learning process can include knowledge acquisition (P7), and it offers a great opportunity to nurture interdisciplinary methods (P7), but one also has to address the question of what happens to the students' motivation after the initial hype and how to maintain their attention and their willingness to learn (P7). While it is imaginable that the individual student or teacher can go from one virtual room or world to another individually and effortlessly, their motivation has to be maintained, as P7 mentioned the repetitiveness of the environments or mechanics can cause boredom (which also highlights how resource-intensive it is to continuously create new pedagogical content for virtual environments). Therefore, it is important to reframe the educational settings into a more 'experiential learning' (P12), where, besides the simulation-based trainings, other soft skills (e.g., social skills) would also be developed, for example, with the help of role-playing (P16, P19). According to P7, in didactics "there would not be a paradigm shift, but rather a continuation of existing concepts." These concepts that could be tested in virtual reality environments are action orientation, sensitive learning, and creative learning in the constructivist sense, and these could be tried out in more innovative ways.

Some participants also opined that "the teaching curricula should be directed more towards Low-Tech" and the content types should be developed more and not just the platform itself (P15).

5 Discussion and conclusion

As discussed in the Metaverse Roadmap Paper in 2006 (Smart et al., 2006) these technologies have various manifestations and all the described scenarios impact what nowadays we consider metaverse-related technologies. This was not only emphasized by how in the past years technologists described it (see Zuckerberg, 2021) but also show how enduring the early thinking is. The wording

used by the professionals in terms of what characteristics and affordances do metaverse-like environment has overlaps with what is communicated by the technology enablers (e.g., Meta Company).

Based on the participant's input it can be identified that the barriers of integrating technologies are still a current issue and the complexity of the technology is not supporting this process. A more value-oriented approach is needed as was expressed by the participants. While the cost, accessibility, and the digital divide were not a subject of this research, it can be pointed out that the cause of the "fluidity" of the concept is also caused by the lack of access to these technologies and environments and therefore also the lack of hands-on knowledge. However educational professionals have multiple approaches on how to interpret into their practices the potentials of the metaverse-technologies and also on how to integrate these into their curricula. On the other hand, a lack of technical skills for hands-on practice is also present. While many of the participants emphasized the importance of the promise of interconnectedness, the technological understanding of how this interconnectedness is enabled is currently not transparent to them. This means that the bridge between academia and technologists should be more connected (Butler and Sellbom, 2002). Therefore a clearer knowledge-sharing and educational type of communication would be needed from the enabler companies which could foster educational professionals to deploy metaverse-like environments in their curricula.

Privacy and security concerns were addressed about data security, and creating a safe educational environment is a current issue. However, due to the limited access to technology, the scenarios to create these are scarce. The psychological burden can be also observed: as the affordances of these environments of creating a strong sense of presence and embodiment tend to heighten the experiential aspect of learning, this can create a fast level of saturation in terms of knowledge or skills requirement in students. The knowledge sharing would also create the opportunity for having these technologies more integrated into the educational curricula and it would mean that more educational professionals would be prepared to create new learning scenarios for students that can help them to be more ready to understand the metaverse-like environments and its technologies possibilities and challenges.

The potential for developing enhanced social environments for learning has been recognized. While the shift towards experiential learning can impose significant psychological burdens on participants (e.g., similarly like in the case of short-form videos that can cause difficulty in maintaining attention and attention deficit, as described in the case of TikTok videos see (Chen et al., 2023), it simultaneously presents opportunities for deeper comprehension of complex subjects within a collaborative context that accommodates diverse perspectives. The virtual environments facilitated by metaverse-related technologies allow for the simulation of various scenarios, thereby enabling an experiential exploration of interconnected topics worlds (e.g., students can try out such situations that might be dangerous or less accessible in physical setting). This approach not only fosters engagement but also enriches the learning experience by integrating multiple viewpoints in a shared digital space.

The results of this study highlight several practical avenues for educational institutions seeking to leverage metaverse technologies. We identified three main areas where the results of this research could be integrated into practice:

1. Professional development programs: Creating professional development programs focused on enhancing educators' technical skills will empower them to utilize metaverse environments confidently. This initiative could be supported not only by higher education institutions but also by policy-making bodies and governmental agencies, as it has the potential to enhance national education curricula.
2. Curricular integration: Integrating metaverse-related projects into existing curricula can provide students with hands-on experience that prepares them for future technological landscapes. This approach can also foster critical thinking skills regarding these virtual spaces. However, continuous experimentation and quality assessment are needed to facilitate the ongoing enhancement of these integration processes.
3. Contribution to national and regional metaverse strategies: By fostering an ecosystem of collaboration and innovation, educational institutions can enhance their pedagogical approaches and better equip students for success in an increasingly digital world. This approach can foster national and regional initiatives and facilitate the development of various metaverse strategies that are tailor-made for specific regional needs and goals. Establishing an institutional framework to initiate such cross-sector partnerships could enable the successful implementation of these initiatives.

In this study, we mapped (only partially, due to the limited space) the current status of how the metaverse(s) and other related technologies are assessed and deployed by professionals working in higher educational institutions, and we grouped the information gathered from 20 in-depth interviews around two themes, "how the future is not what it used to be" and "how it is not here yet." With this we aimed to uncover possible pathways that can help designers of these spaces to re-think or further develop spaces for education, where experience-based learning can be assessed, many skills can be taught in parallel, and the new sense of embodiment can become a tool for critical thinking about virtual identities. The findings suggest that bridging the gap between educational professionals and technology enablers is crucial for meaningful integration. However, as the technologies enabling virtual worlds are still in development and represent an emerging trend, numerous ambiguities remain regarding their practical application, educational value, and long-term sustainability.

6 Limitations

This study is limited by its scope, as it only partially maps the current status of metaverse-related technologies in higher education through a small sample of 20 in-depth interviews. The findings may not be generalizable across all higher educational institutions around the world, given the diversity of experiences and resources available. Additionally, the research did not address entirely critical factors

such as cost, accessibility, and the digital divide, which could significantly influence the integration of these technologies.

7 Future research

Future research should aim to include a broader range of stakeholders and contexts to provide a more comprehensive understanding of the barriers and opportunities associated with metaverse adoption and should focus on exploring the specific barriers that educational professionals face when integrating metaverse technologies into their curricula. Investigating the impact of cost, accessibility, and digital literacy on technology adoption will be crucial for developing effective strategies to overcome these challenges. Furthermore, longitudinal studies could provide insights into how the understanding and application of metaverse technologies evolve over time within educational settings.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

ÁB: Conceptualization, Writing – original draft. JB: Conceptualization, Writing – review and editing. PB: Data curation, Writing – original draft. FP: Data curation, Funding acquisition, Methodology, Project administration, Resources, Validation, Writing – original draft.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that Generative AI was used in the creation of this manuscript. Generative AI (Google Gemini) was used in the Discussion part, for editing purposes.

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