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# Metaverse as a Learning Environment: Some Considerations

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**Abstract:** The metaverse is unavoidable in an increasingly digitalized society and will potentially have a profound influence on what is understood as teaching and learning in its formal and informal dimensions, both in initial and continuing education. This research, carried out through document analysis, aims to reflect on several challenges and opportunities that the metaverse poses to education as a source of opportunities for a more relevant and effective teaching process, which necessarily involves the development of both the implementation and monitoring of research studies in the follow-up of education in the metaverse environment.

**Keywords:** curriculum; ethics; future of education; learning process; metaverse; teaching; virtual classroom; virtual reality



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## 1. Introduction

According to several authors, we are increasingly living in a super-smart society, characterized by the close connection between artificial intelligence, the internet of things, big data, and man [1–5]. This factor increases the influence of this technology and the way it is mobilized in the (re)definition of one's individual and collective identity [6–8] and the consequent interest in the study of cultures and online communities [1–7].

It was in this context that the COVID-19 pandemic, and the consequent security measures related to physical distance, boosted the increasing implementation of the digital dimension [3,9–11] in many of the sectors of life, of which we highlight for the purposes of this paper. These include education through elements such as online classes, virtual conferences, and lectures, among others [12].

A subsequent phase is the growing interest and presence of the metaverse, which, in a way, deepens the digital dimension in social and economic life and, potentially, in education itself [13–15] in the (possible) development of the United Nation's Sustainable Development Goal 4—quality education. However, the metaverse as a learning environment is a topic that is (still) very little studied [16].

Suh and Ahn [14] point out four reasons for this emergence of the metaverse. Firstly, this trend stems from the technological evolution we have been witnessing. Secondly, as a result of COVID-19 and the inevitability of using virtual communication, of which education is a paradigmatic example. Thirdly, the so-called Generation Z (the digital natives, known colloquially as zoomers) have profoundly changed the consumption patterns of cultural goods. Finally, the massive dissemination of mobile devices (PCs, mobile phones and tablets, among others) and access to the Internet from anywhere and at any time has allowed everyone to access the metaverse.

However, what is the metaverse all about? First, it is pertinent to emphasize that it cannot be confused with any exclusive software program or specific platform exclusive to any company or even of a state/public entity, state, or governmental nature [17–19]. It is not easy to present a single definition [20], but the one that follows seems enlightening to us:

The metaverse is a post-reality universe; it is a perpetual multi-user environment that combines physical reality and digital virtuality. It is based on the convergence of technologies that enable multisensory interactions with virtual environments, digital objects, and people, such as virtual reality (VR) and augmented reality (AR). As a result, the metaverse is a web of social and networked immersive environments on persistent multi-user platforms. It allows for real-time embodied user communication and dynamic interactions with digital artifacts [21] (p. 278).

The metaverse is intrinsically linked to Web 3.0 [18,22] and blurs/fuses the physical and virtual dimensions [23,24] in what Allam et al. [25] call *phygital*. In addition, the metaverse is shaped as a continuity that merges the physical and the virtual worlds, largely through the existence of "avatars" as digital identities [16], a "digital representation of oneself in the digital world" [25] (p. 777), which raises profound and emerging challenges [26].

Given its extreme complexity and novelty, the enormous potential of the metaverse is not yet fully realized [19,22,27,28]. Dionisio et al. [26] point out four characteristics deemed fundamental elements for a fully realized metaverse (Figure 1).

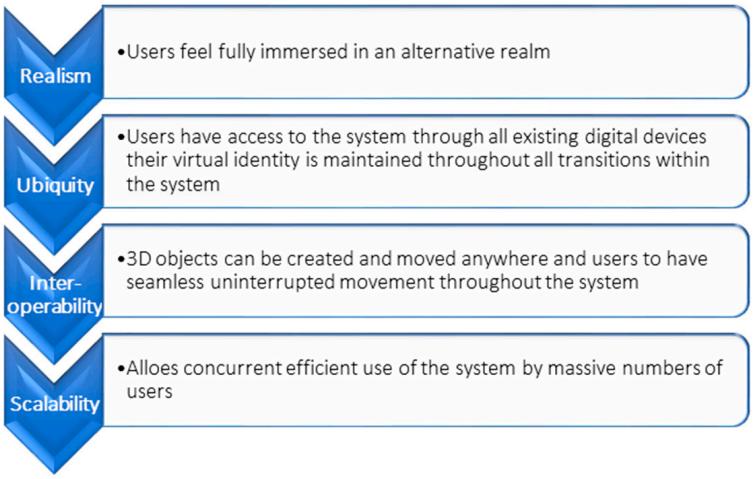


**Figure 1.** Fundamental elements for a fully realized metaverse. Source: Adapted from Dionisio et al. [26] (pp. 28–29).

This study thus seeks to contribute to a reflection on challenges that metaverse education poses as a source of opportunities for more relevant and effective teaching; it is structured according to the following points: The Metaverse and Digital Society, The Metaverse and Education, Changes in Teaching, and Challenges. The paper ends with the presentation of the conclusions that this study allowed reaching.

## 2. Materials and Methods

The methodological approach used in this research study is qualitative and the research technique used in the analysis of the data collected was content analysis, as it allows for the compression of a high amount of words and text into fewer content categories based on explicit rules of coding [27–29]. Content analysis is, thus, a powerful technique that allows for filtering large volumes of data more easily and systematically [28,30].

The authors carried out a thorough literature search. The search terms used were metaverse, education, teaching and learning process, virtual classroom, virtual reality, and ethics, which were mentioned either in the title or in the abstract. The search was performed between 2 and 10 September 2022 and the databases searched were B-ON [31] and SCILIT [32]. The B-ON database incorporates the Web of Knowledge, SciELO, and DOAJ databases, among others, whereas the SCILIT database covers all documentation to which a DOI (Digital Object Identifier) has been assigned. This literature search resulted in 51 publications, described in Table 1.

**Table 1.** Document sources analyzed and their characterization.

| Type of Document | | Geographical Scope | | Year of Publication | | | |
|---|---|---|---|---|---|---|---|
| **Theoretical/Conceptual** | **Empirical** | **International** | **National** | **2022** | **2021** | **2020** | **Prior to 2020** |
| 45 | 6 | 45 | 6 | 34 | 5 | 3 | 9 |
| Total: 51 publications | | | | | | | |

Source: Authors' production.

The research studies authored by scholars from all the continents are represented in the literature review, albeit with very different weights in terms of their number. The majority of the authors of the research studies analyzed (93) are affiliated with European educational institutions (Cyprus—2; France—7; Germany—2; Greece—1; Ireland—36; Italy—11 Netherlands—1; Norway—5; Portugal—4; Spain—2; Switzerland—1; Turkey—8; and UK—13). The Asian continent follows, with 65 authors (China—17; Hong Kong—3; India—10; Japan—1; Korea—13; Malaysia—2; Qatar—2; Saudi Arabia—1; Singapore—8; Taiwan—3; Iraq—1; Jordan—2; Pakistan—1; and Palestine—1). In third place are the North American authors (28) (Canada—6; USA—19; and Panama—3). The fourth continent is South America, with 6 authors (Brazil—4; Chile—1; and Peru—1). The two least represented continents are Oceania, with four authors from Australia, and Africa, with one author from Morocco, one from South Africa, and one from Tunisia.

## 3. The Metaverse and Digital Society

The metaverse, as a fully immersive digital environment, is accessed through an avatar with a digital time-space, which is not necessarily the same as the physical world [26,33,34] (for further development, see Mistretta [10]; Abbate et al. [13]; Suh and Ahn [14]; Cui et al. [15]; Zhang et al. [16]; Knox [17]; Damar [19]; Lim et al. [23]; Tlili et al. [24]; Allan et al. [25]; Song [33]; Jiaxin and Gongjing [35]; Khala [36]; and Yue [37]).

Momtaz [38] defines the metaverse as a "[ . . . ] shared vision among technology entrepreneurs of a three-dimensional virtual world, an embodied internet with humans and the physical world in it" (p. 228). The defining traits of the metaverse are detailed in Table 2.

**Table 2.** Defining traits of the metaverse.

| Categories | Defining traits |
|---|---|
| Infrastructure | The metaverse is a persistent virtual system with real-time information processing capabilities that can cause the current state of knowledge to be available to all users at the same time at all times. |
| Architecture | The metaverse is a decentralized platform that features a high degree of interoperability to enable the mobility of digital identities, experiences, and possessions across the metaverse from one place, event, or activity to another. |
| Human couth | The metaverse overcomes the limitations of Web 2.0-based virtual realities by enhancing users' self-perception and presence, increasing human interactivity, and improving realistic expressions of human qualities, such as emotions. |

Source: Adapted from Momtaz [38] (p. 228).

In turn, Jaber [39] schematizes, in a very comprehensive way, the metaverse architecture with the integration of digital worlds and the human and physical worlds (Figure 2).

Jaber [39] sustains that this complex system is composed of a set of components that include (1) humans (which are at the core of the metaverse); (2) the physical infrastructures (the real/physical world); (3) the interconnected virtual worlds (named the sub-metaverse); (4) the metaverse engine (whose functioning is fed through the use of blockchain, artificial intelligence, interactivity, and digital twin technologies; (5) the in-world information flow (the technologies permanently update the virtual world through the inputs from the real world); and (6) the flow of information across physical and virtual worlds).

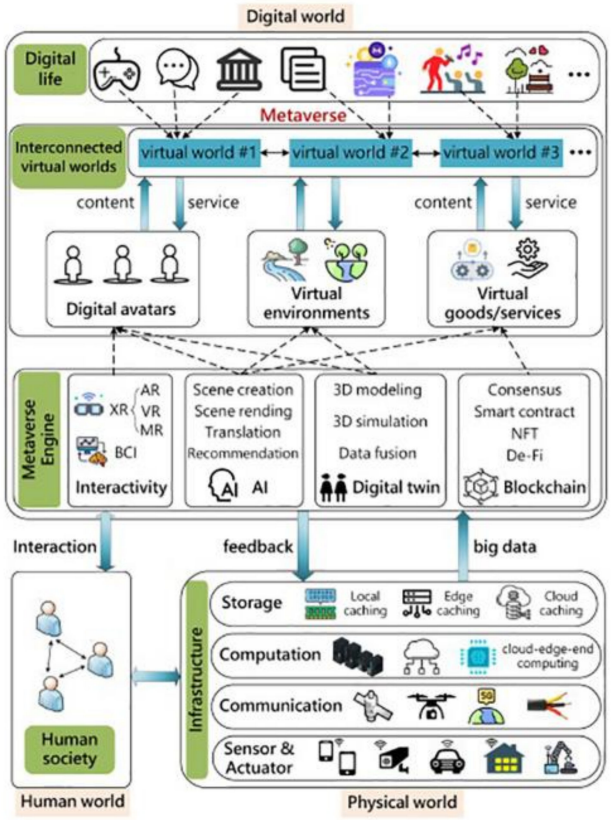


**Figure 2.** Metaverse architecture with the integration of digital worlds and the human and physical worlds. Source: Jaber [39] (p. 7).

The metaverse will shape the future and even human identity, providing more intuitive ways of human-technology interaction [24]. The metaverse will articulate the representation of individuals in the physical world with their digital representation in the virtual world and the respective forms of communication and interactions [15,17,33,40–42].

According to Song [33], communication in the metaverse bounces between the real and virtual worlds. The individuals can communicate physically in the same space and concomitantly interact from different worlds, moving from online to offline environments and vice versa, adding complexity to the process.

In education, the concept of skeuomorphism—combining, in the virtual world, objects and environments that are similar to those in the physical world—can be used to enhance the educational experience, allowing for the design of a very personalized metaverse, thus creating the illusion that teachers and students are in the same real/physical space [16]. Therefore, given the potential advantages of the metaverse, its use in education is likely to be widespread in the near future [43].

The use of the metaverse specifically in the educational context is discussed in the next sections.

## 4. The Metaverse and Education

The metaverse and education—and, particularly, higher education—are intertwined to the extent that, in contemporary education, they are always digitally mediated; students share virtual spaces, methods, and content that enhance both their academic and personal development. However, there are many skeptical voices about the relevance of the metaverse in education, believing that it can be misleading in terms of improving the educational process [37].

However, other authors, such as Tlili et al. [24] and Yue [37], for example, maintain that the metaverse contributes to enriching the educational process, including the teacher-student relationship, which, through the metaverse, has no barriers in terms of time and

space. Moreover, the metaverse is fundamental to changing the classic educational model, which is traditionally static, to a dynamic model by mobilizing a wide range of situations, methods, tools, and forms of learning and assessment and placing the student at the center of the educational process, which potentially increases their motivation for learning [24].

Thus, according to Damar [19], higher education institutions should strive to incorporate topics related to the metaverse in their educational processes, such as virtual reality, augmented reality, simulation technology, 5G networks, artificial intelligence, cloud computing, 3D content creation, and blockchain technology, among others, as a way to better prepare their students and equip them with knowledge and skills that enable them to successfully face the challenges and demands of the labor market, with a more appropriate and redesigned curriculum [44]. These skills, not only technical but also soft or transversal skills, include complex problem-solving, adaptability, creativity, leadership, proactivity, critical thinking, creativity, teamwork, coordination with others, emotional intelligence, judgment and decision-making, service orientation, negotiation, and cognitive flexibility [10,45].

## 5. Changes in Education

Kye et al. [11], acknowledging an increasing convergence between these four dimensions, define the four types of the metaverse (augmented reality, lifelogging, mirror world, and virtual reality), which, for the purpose of analysis, seem highly relevant, as it is an instrument that enhances the heuristic capacity to grasp, in a more global way, the relationship between education and the metaverse. While these four types of metaverse were initially developed as independent of each other, they eventually evolved toward their convergence and interaction [11]. Table 3 details the four types of the metaverse as defined by Kye et al. [11].

**Table 3.** Four types of the metaverse.

| | Augmented Reality | Lifelogging | Mirror World | Virtual Reality |
|---|---|---|---|---|
| Definition | Building a smart environment by utilizing location-based technologies and networks | Technology to capture, store, and share everyday experiences and information about objects and people | It reflects the real world as it is, but integrates and provides external environment information | A virtual world built with digital data |
| Features | Building a smart environment using location-based technology and networks | Recording information about objects and people using augmented technology | Virtual maps and modeling using GPS technology | Based on interaction activities between avatars that reflect the user's ego |
| Applications | Smartphones and vehicle HUDs | Wearable devices and black boxes | Map-based services | Online multiplayer games |
| Use cases | Pokemon Go, Digital Textbook, and Realistic Content | Facebook, Instagram, Apple Watch, Samsung Health, and Nike Plus | Google Earth, Google Maps, Naver Maps, and Airbnb | Second Life, Minecraft, Roblox, and Zepeto |

Source: Adapatexd from Kye et al. [11] (p. 3).

Each of these types of metaverse has distinct technical/technological characteristics and also different implications in the educational context, presented in Table 4.

Given the above, it is essential to analyze the roles the metaverse plays in existing teaching, learning, and assessment processes, designs, and strategies in education [46]. According to these authors, the use of the metaverse in educational processes offers both students and teachers the possibility to experiment with new and innovative approaches and forms of teaching and learning, as well as to interact with the academic community, including by emulating the real world through virtual reality [46].

**Table 4.** Main technical/technological characteristics of the metaverse and educational implications.

| Type | Technical/Technological Characteristics | Educational Implications |
| --- | --- | --- |
| Augmented reality | - Overlay virtual objects in the real world to cause the object to seem 3D and real (e.g., paper birthday cards are augmented to appear as 3D video cards) | - Learn invisible parts visually and 3-dimensionally through virtual digital information and effectively solve problems |
| | - Adding fantasy to the thread (e.g., Pokémon Go on the street and Zepeto, which recognizes faces and creates 3D avatar) | - In-depth understanding of content that is difficult to observe or explain in text and learners can construct knowledge through experience |
| | - Effectively emphasizing information and promoting convenience (e.g., HUD presented on the car glass) | - Interactive experiences such as reading, writing, and speaking are possible while immersed in the learning context |
| Lifelogging | - One's daily life and thoughts are productively turned into content and shared through social media and SNS (e.g., blogs, YouTube, Wikis, etc.) | - Review and reflect on one's daily life, improve the ability to represent and implement information in an appropriate direction, and feedback from others on social networks leads to reinforcement and rewards |
| | - - Network technology forms relationships with others online, communicates quickly, and records various social activities (Facebook, Band, Twitter, etc.) | - Critically explore various information on the lifelogging platform and creatively reconstruct information through collective intelligence |
| | - Personal activity information is accumulated and analyzed through various sensors of the internet of things and wearable devices to create added value (e.g., health tracking including Nike Plus) | - Reflect on learning and improve it based on analytics data related to learning (e.g., dashboard) |
| | | - Teachers promote learning in a customized direction based on students' learning log data, provide appropriate support, and prevent dropouts |
| Mirror world | - Expanding the real world by combining GPS and networking technology (e.g., Google Earth, various map applications, etc.) | - Overcoming the spatial and physical limitations of teaching and learning, learning occurs in the metaverse of the mirror world |
| | - Implementation of the real world into the virtual world as if reflected in a mirror for a specific purpose (e.g., Airbnb, Minerva School, food ordering app, taxi call, bus route guidance, parking lot finder app, etc.) | - Conduct online real-time classes through online video conferencing tools and collaboration tools (Zoom, WebEx, Google Meet, and Teams), which are representative mirror worlds |
| | - However, it does not contain everything in reality. In other words, it effectively expands the real world to increase the fun and playfulness, flexibility in management and operation, and collective intelligence (e.g., Minecraft, Upland, Digital Lab, etc.) | - Through the mirror world, learners can realize "learning by making" (e.g., in Minecraft, students build and restore historical structures—Bulguksa, Gyeongbokgung, Cheomseongdae, Taj Mahal, Eiffel Tower, etc. Users can experience their digital heritage and deepen their understanding of history and culture |

**Table 4.** *Cont.*

| Type | Technical/Technological Characteristics | Educational Implications |
| --- | --- | --- |
| Virtual reality | - Through sophisticated computer graphics work, especially in a virtual environment implemented with 3D technology, users enjoy various games through a seamlessly connected interface (e.g., various 3D games including Roblox) | - Practice can be performed through virtual simulation in environments that are difficult to produce due to high costs and high risk (e.g., fire scenes, flight control, dangerous surgery, etc.) |
| | - In a space, era, or culture and with characters designed differently from reality, they act as avatars rather than their original selves and have multiple personas | - Users can have immersive experiences of times and spaces that cannot be experienced in reality, such as the past or future |
| | - Chat and communication tools are included in virtual reality to communicate and collaborate with AI characters and others (e.g., multiplayer online games) | - Through 3D virtual world-based games (according to the characteristics and types of designed games), users improve strategic and comprehensive thinking skills, problem-solving skills, and learn skills necessary for the real world |

Caption: 3D, 3-dimensional; HUD, head-up display; SNS, social networking service; GPS, Global Positioning System; and AI, artificial intelligence. Source: Adapted from Kye et al. [11] (p. 8).

Hwang and Chien [46] argue that there are several relevant advantages and potentials of using the metaverse in education, as shown in Figure 3.


**Figure 3.** Reasons for adopting the metaverse for educational purposes. Source: Adapted from Hwang and Chien [46] (p. 3).

The metaverse classroom is very different from the traditional one, in that it is a virtual space equipped with digital resources and tools shared by teachers and students and is where physical and virtual reality are interwoven [41]. The visible advantages it has for the teaching and learning process cause it to be an increasingly used tool in educational institutions and incorporated into the curriculum [44]. It is what Wu and Gao [47] (p. 1082) call the "Edu-Metaverse", which the authors define as the metaverse applied to education. In this virtual scenario, educational actors are assigned digital identities and, through the use of information technologies, such as virtual reality, augmented reality, the internet of things, and blockchain, for example, interact in formal and informal teaching contexts in the virtual world. This allows for overcoming some of the barriers that traditional teaching

and learning venues face, such as time and space, while actors have the possibility to learn both physically and virtually in an open and shared space, as well as increase participant motivation [16]. These new tools offer a world of new possibilities to both teachers and students to enrich the teaching and learning process, as "Schools and students can carry out virtual extracurricular activities and teaching practices through virtual museums, libraries, museums, science and technology museums, etc., which [ . . . ] achieves students' comprehensive and healthy development" [47] (p. 1083).

According to Zhang et al. [16] (p. 11), there are specific contexts that further value the application of the metaverse to virtual experiments, such as:

1. To assist the experiments that could be risky, irreversible, or toxic in the real world, e.g., an experiment with a potential risk of explosion;
2. To assist the experiment conditions and scientific phenomena that could not be possible in the real world, e.g., an experiment that needs to be carried out in a vacuum;
3. To assist the experiments that need relatively high costs and funds in the real world, e.g., an experiment that needs expensive equipment and materials;
4. To assist the experiments that react slowly or need long-term observations and records in the real world, e.g., an experiment needs learners to observe and record the whole growth stage of an insect.

With this new educational approach, the classroom is just one of many places where learning occurs because, through the metaverse and its use in education, anyone can attend a class, a lecture, or a seminar without having to be in the physical place where it occurs but from virtually anywhere in the world and in real-time. This dramatically increases the possibilities for everyone but especially those who encounter more obstacles in accessing education to develop their knowledge and skills faster than ever before [37].

Dwivedi et al. [48] divide the applications of the metaverse into two categories: (1) the metaverse as a tool, i.e., in cases where the metaverse is used to solve situations in the real, physical world; and (2) the metaverse as a target, i.e., how the metaverse can be used to develop and generate profits, among other things (Figure 4).

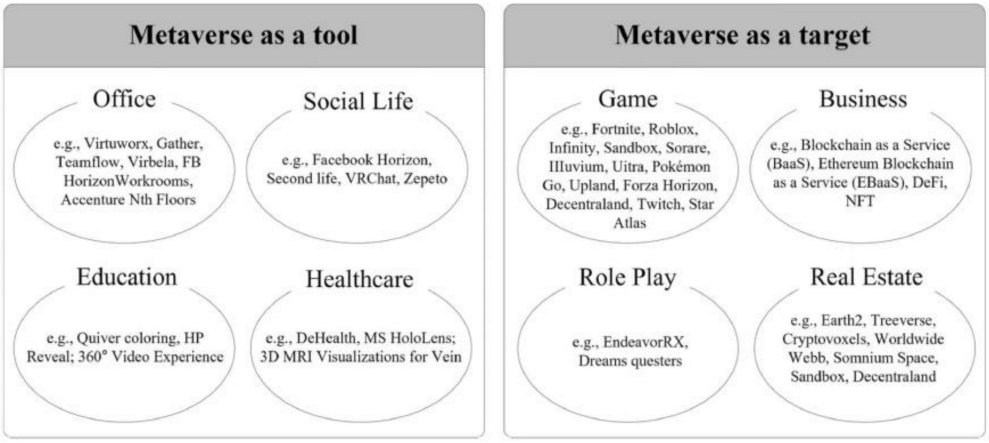


**Figure 4.** Applications of the metaverse as a tool and as a target. Source: Dwivedi et al. [48] (p. 5).

While, in its earlier stages, the metaverse was used mainly as a tool to address and solve problems in the real world (through digital applications and programs used in contexts such as work, education, social life, or healthcare, for example), it has now evolved to being used as a target, meaning that the metaverse itself, through new and improved digital applications and programs, can "[ . . . ] perform actions such as developing the metaverse and generating profits" [48] (p. 7).

In terms of the application of the metaverse to education, Dwivedi et al. [48], in line with other researchers [49], also argue that educational actors, namely teachers and students, can interact in the virtual world, which mimics the real, physical one. The research

conducted by Dwivedi et al. [48] (pp. 36–37) allowed for reaching five relevant propositions about the importance of using the metaverse in education:

**Proposition 1.** *The use of metaverse in education should mirror the real-world learning environment for learners and educators. The metaverse can extend the forms of learning by providing learning opportunities that would not be possible otherwise.*

**Proposition 2.** *The use of metaverse can better facilitate new forms of training and go beyond the capabilities of the physical classroom and e-learning platforms combined.*

**Proposition 3.** *Educators need to elevate their pedagogical methods and course syllabus to accommodate teaching in the metaverse.*

**Proposition 4.** *New metrics need to be developed for evaluating learning experiences in the metaverse.*

**Proposition 5.** *Education providers need to offer new technical equipment and train educators on how to serve their learners in the metaverse.*

The authors maintain that the introduction of the metaverse in education represents a huge change in current teaching and learning processes and in the interactions between teachers and students, who are now able to maintain a relationship independent of time and space, using virtual spaces for teaching and learning, to bring innovation to educational processes and to extend learning opportunities [48].

In addition, in a metaverse, learning mobilizes their full potential:

> [ . . . ] there are two forms of teachers and peers that learners can interact with: one is avatar teachers and peers, and another is intelligent NPC teachers and peers. On one hand, through interaction with teachers and peers in the form of avatars or intelligent NPCs, learners can get more emotional support and real-time feedback instead of just looking at a grid of faces or boring slides on video-conferencing platforms. On the other hand, intelligent NPC teachers and peers can help to implement learning activities and give personalized support during class or after class. Social constructivism has emphasized that an individual's knowledge is constructed through social interactions [ . . . ]; hence, it could be a reason for using the metaverse in education for the cognitive and social development of learners [16] (pp. 7 and 9).

It is interesting to note that NPCs (Non-Player Characters) originated within the context of computer games, consisting of a character controlled by the computer, rather than the player [50]. This concept has been applied to the metaverse-based learning environment, namely in terms of intelligent NPC teachers, intelligent NPC learners, and intelligent NPC peers, all of whom play a pivotal role in "[ . . . ] supporting arbitration, simulation, and decision-making for educational purposes" [16] (p. 6). The use of NPCs in education enables addressing personalized needs and eases the interaction between students and teachers [16].

## 6. Challenges

One of the main advantages of using the metaverse in education is that it allows all people around the world (provided they have the technical conditions) to access education without being constrained by physical barriers [37].

As with the emergence of any new technology, there are different perspectives on the metaverse [51] applied to education, some positive and others a little more reticent [13]. Yue [37] argues that the interaction between teachers and students will change completely, as will the ways in which education is delivered to students. Education will be democratized and accessible to all, regardless of their economic, cultural, or social background. Conversely, Floridi [22] (p. 7) expresses his concern that the "digital divide will increase

rather than decrease" with the use of the metaverse in education, as not all individuals have equal and adequate access to what he calls the extended experience and many may be left out. Mistretta [10] is also skeptical about the complete replacement of face-to-face learning with virtual learning while acknowledging its importance in providing teachers and students with a space where educational experiences can happen in a hybrid format.

The metaverse applied to education can be an excellent way to help a special group of individuals such as those with autism spectrum disorders (ASD), those with social anxiety disorders, and those with physical disabilities, for example [9,14,52]. These individuals have, in this new educational setting, the opportunity to learn various social skills and to grasp the learning opportunities created by the metaverse. In this regard, Gülen et al. [53] argue that virtual freedom in terms of time and space can help education become more inclusive and foster participation for all, particularly students who have disabilities:

> The learning analysis module aims to utilize massive data to analyze and display learners' learning performances and achievements by unit or in all. More significantly, it can make assessing learners' performance easier, and provide teachers with reliable proof to conduct personalized services for learners [16] (p. 7).

The opportunities for using the metaverse environment to improve the quality of education are numerous. Gülen et al. [53] provide a good example of such an opportunity in the field of STEM (Science, Technology, Engineering, and Mathematics) studies. The authors maintain that this environment "[ . . . ] will provide the development of cognitive, affective, and psychomotor skills for the learner. [ . . . ] will improve cooperation and teamwork. [ . . . ] Virtual classrooms will facilitate access to hard-to-see experiments and applications. [ . . . ] will provide a modelling opportunity. [ . . . ] will provide equal opportunity for disadvantaged groups" [53] (pp. 101–102). The authors further comment that the application of the metaverse to STEM education has challenges, namely in terms of the necessary equipment, software, internet structure, legal ambiguities, and potential disconnection from the physical world [53].

In the same vein, Kye et al. [11] (p. 10) draw attention to the fact that while the metaverse has great potential in education, it also has some shortcomings that need to be addressed. The line between the real and virtual world becomes more blurred, which can cause some confusion among users regarding their "'real me' identity". Thus, the authors present the main characteristics of the metaverse, along with its merits and weaknesses when applied to education (Table 5).

**Table 5.** Characteristics of the metaverse and the merits and shortcomings in its educational applications.

| Metaverse Characteristics | Merits | Shortcomings |
|---|---|---|
| New social communication space | Even in the case of school closures due to coronavirus disease 2019, students can socially connect beyond the limitations of reality | When forming a relationship with others, one forms a relationship centered on play that is weaker than interaction in the real world; privacy problems occur due to the collection and processing of various pieces of personal information |
| High degree of freedom | Expanding student autonomy in the learning process by providing experiences from content consumers to creators | Due to the high degree of freedom, platform administrators cannot predict all the actions of users and they can be exposed to various crimes due to the virtual space and anonymity of the metaverse |
| Through virtualization, high immersion | By providing a new experience that transcends time and space, it is possible to increase student interest and immersion to expand students' active participation in learning | It can cause identity confusion, escape from reality, and maladaptation to the real world for students whose identity has not been established |

Source: Adapted from Kye et al. [11] (p. 11).

Furthermore, Wu and Gao [47] warn about the risks that the so-called "edu-metaverse" entails. The authors mention the following as the most important:

i. There is no high-level design or systematic planning and explicit development goals in terms of implementing the metaverse in education;
ii. There is a lack of theoretical and applied research in the field of the edu-metaverse, i.e., the educational products used in the edu-metaverse environment are not sufficiently based on systematic and scientific theoretical support in the educational field.
iii. There is a risk of ethical issues arising from the use of the edu-metaverse, as data as information about individuals is easily accessible and is used for unethical purposes. On the other hand, the sources of data and information are increasingly complex, which may lead to issues of trust on the part of users. In addition, and perhaps most importantly, the edu-metaverse is highly immersive and interactive, which can present a real risk of addiction for students.
iv. There is a risk of capital manipulation, inasmuch that under the general consideration that the edu-metaverse can reduce the existing education gap, it is critical to analyze whether capital can be the edu-metaverse and thus impede educational equity and perpetuate the digital divide [47].

It is a fact that, as a metaverse, its use in education and the construction of virtual identities have several benefits, but this scenario is not without disadvantages. The thin line between real and virtual identities and the still low support, both technically and financially, for the construction of virtual identities can hinder the communication process [13,33]. This process has the potential to combine the real and virtual worlds to prevent students from becoming totally disconnected from the real world, "[ . . . ] losing their due judgment and self-knowledge, and causing the deviation of thought and behavior" [54] (p. 7). However, a good deal of risks emerge in both metaverse and virtual environments, which stem from digital technologies, such as the issue of "[ . . . ] privacy, abuse such as bullying or virtual violence, computer crimes, cyber-attacks, vandalism and hacker attacks, or how ransomware and pornography might develop" [22] (p. 6) or "[ . . . ] problems of addiction and escape from reality generated by the Metaverse" [22] (p. 7). Jiaxin and Gongjing [35] also point out that although the metaverse applied to education enhances the teaching and learning process, it may entail ethical issues, namely in terms of privacy, cyber-bullying, and deceiving educational inequalities. The avatars created in this virtual environment are a further challenge, as there is no consensus on whether the real individual is the source of the avatar's actions and behaviors or whether the real individual assigns the avatar a new role [46].

On the other hand, potential legal issues may also arise with the use of the metaverse, namely "[ . . . ] data protection and privacy, intellectual property rights and personal harm" [55] (p. 490).

The use of metaverse has direct implications and consequences for the individual's privacy and entails security and ethical risks [11,39,40]. The data produced or searched online can be traceable, whether it is active or passive data. The former is produced when an online user actively clicks, comments, or forwards any piece of information on a particular online platform. The second concerns the personal information that users unintentionally leave on an online platform, such as their geographical location, social relationships, voices, and faces, notwithstanding the "user informed consent" present in many platforms, thus increasing the potential risks and dangers of metaverse use [34,56].

In their comprehensive review of the various educational use cases of the metaverse, Jagatheesaperumal et al. [56] provide a summary of the different educational scenarios, the challenges each faces, the intended goals and countermeasures to address the challenges emerging from metaverse-based education/training in different fields (Table 6).

**Table 6.** Metaverse enabled education, training, and skill development. Challenges and countermeasures.

| Application | Challenges | Goal | Countermeasures |
| --- | --- | --- | --- |
| Healthcare education | Handling multi-modal medical data and streamlining | Innovative drive in medical education | New directions to the healthcare education sector could be driven through the integration of metaverse with AI, VR, AR, IoMT, Web 3.0, intelligent edge, cloud services, robotics, and quantum computing |
| Online education | Collaborative efforts and interactions | Immersive experience for teachers and students | Appropriate choice of XR and IoE equipment with dedicated seamless connectivity targeted for meeting the demands of the teachers and learners |
| Industrial training | Training robots and skill enhancement for labors | Monitor and control complex manufacturing units | Binding the hardware and software components of metaverse in the manufacturing, supply chain, design, development, and virtual warehousing to drive the market revenue and forecast the impact of technology over the next few years and make decisions accordingly |
| Aircraft maintenance training | Maintenance, status monitoring and control | Intuitive and efficient control of functional modules in aircraft | 3D twin models of aircrafts help to read the aircraft log books and records, which includes the entries of the condition of the internal equipment, status, and intimates the requirements for the learners and users in the remote place |
| Marine maintenance training | Handling of cybersecurity issues | Robust defense mechanisms against treats | Integration of metaverse with blockchain based technological trends, helps to reduce errors in maintenance tasks with secured means of handling the challenges with increased safety through alerts and notifications |
| Military training | Replicating the war scenes and dynamic adaptation | Trained to face adverse conditions | Improved productivity with clear instructions through metaverse driven equipment for dynamic handling of war situations |
| Art upskilling | Managing 3D virtual objects | Imagination and creativity to reality | Enhanced quality and accuracy with object recognition for immersive learning with applied creativity beyond the imagination |
| Gaming expertise | Integration of AI for provisioning immersive experiences | Collaborative learning | With unified and interoperable spaces rendered through the graphics, interaction with the people and objects in the virtual worlds causes the gaming platform to have incredible potential in using the metaverse for provisioning a diversified range of education, training, and skill development applications |

Source: Adapted from Jagatheesaperumal et al. [56] (p. 12).

In sum, for the various fields of education/training, the achievement of each immersive learning objectives through the metaverse implies the need to address challenges with appropriate countermeasures [56].

In the context of the COVID-19 pandemic and the need to move from face-to-face teaching and learning to online teaching and learning at all levels of education, one of the critical issues that emerged was teachers' digital literacy. Tlili et al. [24] maintain that this is the best-prepared generation to use and interact with the metaverse educational environment and technologies, although there is still a lack of research to support this assumption. On the part of students, Talan and Kalınkara [43] maintain that they welcome this new educational approach because of its many advantages. Yet, the authors warn of the disadvantages of using the metaverse for educational purposes, such as the difficulty and distraction on the part of some students and their disconnection from the real world.

For all this, it is crucial to carefully weigh the advantages and shortcomings of using the metaverse in the educational environment. First and foremost, it is paramount to understand the students' views and uses of the metaverse, their levels of immersion, and the effects on their learning.

On the other hand, being a virtual world, the metaverse allows individuals to have experiences that they would not otherwise have in the real world, but this may lead to an uncritical acceptance of the content and products offered, which may or may not be suitable to students' needs and/or competencies. Thus, both content and product designers and teachers need to analyze whether what they offer/work on is in line with what students expect so that the teaching and learning process can be fruitful and meaningful for the students [11].

When used correctly, the metaverse applied to education can contribute not only to the achievement by students of hard skills (of a more technical nature) but also of soft or transversal skills [45] and digital skills [57], both of which are highly relevant in the contemporary labor market.

As with anything new, especially in education, caution is needed when using the metaverse in this environment [16]. It is crucial to analyze how students with different personal characteristics see, respond to, and benefit from this new learning context [46]. Wang et al. [49] (p. 5) caution that this new educational approach, characterized by being "[ . . . ] more student-centered, collaborative and innovative" has to be carefully analyzed and designed to fully utilize its potential and mitigate its drawbacks.

## 7. Conclusions

The possibility of transforming the university into a "metaversity" [36] (p. 12) through this transition with a greater centrality of the metaverse in the formative process, as a process with great uncertainties that is totally new, implies the participation and cooperation of several stakeholders.

The government of each country is paramount in leading and monitoring this process of building an educational system that has incorporated the metaverse, i.e., the edu-metaverse setting. In turn, companies that provide services or products related to the metaverse should intensify the research and development of all the technologies that form the basis for the operation of the metaverse, quickly and efficiently solve technical problems, and offer quality services. In addition, these companies should implement the complete management of the data resource chain and permanently improve the supervision and control mechanisms and interact closely with educational institutions to constantly tailor the services they provide to their audience, i.e., the educational community. Furthermore, the general public should make efforts to be more aware of both the potential and the risks of online networks [47].

The metaverse is still a novelty concerning its use in educational settings. As such, there is a need to intensify support and encouragement for its use in educational institutions, as well as to provide platform training through the cooperation of higher education teachers, teaching, and learning centers and other related entities [21].

In any case, there is a need for further empirical and theoretical studies on this topic [10,16,24,43,46], but always keeping in mind that there are several elements that need to be considered when using the metaverse for educational purposes:

> [ . . . ] first, teachers should carefully analyze how students understand the metaverse; second, teachers should design classes for students to solve problems or perform projects cooperatively and creatively; third, educational metaverse platforms should be developed that prevent misuse of student data [11] (p. 1).

Above all, it seems to us that the most important thing will be not to run the risk of being more concerned with virtual reality than with the real one [22].

The use of the metaverse in education is just beginning its first steps and, thus, its users will find many benefits but also many pitfalls arising from its use, especially at a time when research on this topic is still scarce and people lack adequate training to properly use the metaverse in education [24]. Therefore, and for now, educational institutions and students should be cautious and aware of the good and the not-so-good sides of the metaverse.

As with all studies, this one also has limitations. Given that this is a rather emergent topic, there is no substantial prior research, which caused it to be more difficult to find

quality articles, books/book chapters, or conference presentations that drew on the topic under analysis.

Furthermore, while seeking to follow the rules for performing a sound literature search [58], such as using more than one international comprehensive database, it is possible that a search in other databases would provide more studies that would further enhance this research study.

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