Abstract: The pandemic caused by the COVID-19 virus forced the virtualization of educational processes worldwide, which has generated a series of challenges in terms of teaching quality due to the improvisation of its implementation. However, the emergence of the metaverse as a new social scenario has opened new opportunities to overcome the problems inherited by education during this pandemic. The main objective is to explore the use of the metaverse in universities through the new concept of the metaversity. A methodology based on the socio-critical paradigm was applied. The theoretical bases around the metaverse are presented, and it is linked to the current university educational ecosystem through the metaversity. The main characteristics and scope of the metaversity are identified as well as the gaps present for the creation of the new learning ecosystem based on virtuality. The incipient character of the implementation of the metaversity was evidenced, as well as its main potentialities. The virtualization of all processes associated with higher education, caused by pandemic education, makes the implementation of the metaversity feasible, and it should therefore be part of the future research agenda.

Keywords: metaverse; university; extended reality; virtual reality; engineering education

1. Introduction

The pandemic caused by the SARS-CoV-2 virus has negatively affected the quality of education for almost 90% of the world’s student population [1,2]. The primary strategy of educational institutions to reduce the spread of the virus was to avoid face-to-face pedagogical methodologies. In particular, most universities were forced to hastily adapt and migrate the training process to “virtual environments”, giving rise to the so-called Emergency Remote Education (ERE). This type of education has been widely questioned due to its negative repercussions, which, together with the few digital skills that teachers and students have [3], as well as the weak technological infrastructure of the institutions, and the lack of support processes for virtual education [4], has made teaching work much more complex. However, as a counterpart, technology has also been a fundamental pillar in overcoming all these adverse effects left by ERE.

Positive aspects have been derived from implementing ERE, such as incorporating disruptive technologies into the training process, which have been accepted by post-pandemic education, given their proven potential and increasing use by students and teachers. Pedagogical innovation based on emerging technologies has enabled significant advances toward excellent training. In addition, this technology has facilitated the development of new experiences inside and outside the classroom, especially those associated with virtuality.

The virtuality implemented by ERE exposed the need to update many of the existing curricular and administrative processes, as well as the creation of some others, to ensure the internal functioning of these houses of studies, which guarantee their operational continuity under the standards of quality customarily required. In addition, the universities have had...
to learn from the lessons left by ERE, promoting new digital skills for all its actors, which are highly necessary for the hyperconnected context in which post-pandemic society lives, and where technologies such as extended reality have laid the technological foundations for a new university ecosystem.

Role of Extended Reality Technologies in Higher Education in the Post-Pandemic Era

Extended Reality (XR) refers to a group of immersive technologies (virtual reality, augmented reality, and mixed reality) that create electronic and digital scenarios where various types of data are represented and displayed [5]. XR has experienced remarkable progress in recent years, especially in the educational sector, promoted by ERE [6]. This type of technology gives students the possibility to live innovative and personalized pedagogical experiences [7]. The use of XR technologies in the classroom seeks to awaken not only curiosity but also motivation for student learning. This motivation is an important factor usually related to academic performance. Recent literature shows how XR technologies have had a positive impact on student motivation in the COVID-19 era [8–10].

Virtual reality, augmented reality, and mixed platforms created during the pandemic for training purposes are still being used today by higher education institutions. The possibility of creating three-dimensional virtual objects, interacting with them as if they were in the same room, and combining them with real physical elements are some of the reasons why universities follow experiences and pedagogical methodologies based on this type of technology. Despite the above, it has not been possible to consolidate the scientific evidence only around the positive aspects in the educational sector, due to the various disadvantages that show the devices necessary for its implementation in classrooms [11].

The new world scenario has led to the need for universities to look towards the future of the new training model and all the activities that support it, where the capabilities of the new type of student, known as a digital native, are incorporated. Therefore, it appears that the next evolutionary step in the educational field of the university sector is connected to the well-known “Metaverse”.

The metaverse makes it possible to adapt the curriculum to the needs of the student. The metaverse has the power to turn the entire world into a virtual global school [12]. The direct immersive experience students receive in the metaverse encourages teamwork and skill development, as well as engaging students in many ways in the classroom [13]. Usually when the metaverse is used in higher education, it is combined with educational platforms (learning management systems, virtual labs, Moodle, MOOCs), allowing immersive environments to be an important part of instructional topics and simplifying the connection of knowledge [14].

Currently, few studies address in depth the next steps in the use of the metaverse in universities, beyond the use of extended reality technologies for pedagogical purposes. To address this research gap, the main purpose of the study is to explore the new concept of the metaversity as a new ecosystem of higher education, including its main potentialities and weaknesses. For this purpose, the following guiding questions are posed:

- RQ1: What are the main technologies and applications trends of the metaverse in universities?
- RQ2: What does the metaversity mean in higher education in the post-pandemic era?
- RQ3: What are the main problems associated with the use and implementation of the metaversity for higher education?

2. Review of Theoretical Bases

2.1. Definition of the Metaverse

The word “metaverse” is an acronym made up of “meta”, which comes from the Greek language and means “after or beyond”, while “verse” refers to “universe”. So these terms refer to a universe beyond what is currently known. The first recorded use of the term metaverse is usually related to Stephenson’s [15] science fiction novel called “Snowcrash”, but as a concept, its use dates years back to Weinbaum’s [16] novel called “Pygmalion’s
Spectacles”, where the author narrates how one of the characters invents special glasses that allowed them to see, listen, try, and touch things and people in a virtual world.

The recent literature defines the metaverse through different edges and visions [17], but in general, it is seen as the evolution of the internet (web 3.0), a unified network of virtual worlds in three dimensions, which is interoperable, massive in scale, working in real-time, and can be experienced by an unlimited number of users, each having a visual sense of presence and identity, and having the ability to be beyond the limits and controls of corporations and governments [18]. Other characteristics of the metaverse proposed by Stephenson also manage to remain current today, as Mystakidis [19] points out: (1) It is a metaphor for the real world. (2) The virtual avatars of the users are customizable, facilitating telepresence, given the possibility of corporality. (3) Users can communicate with each other within the metaverse and can interact with it. (4) It continues to function and develop, although some or all its members are disconnected.

2.2. Technological Axes and Types of Metaverses

The post-COVID era has been accompanied by increased interest from universities in the metaverse. Increased investment in platform and technology development as well as new features and new applications have characterized this era. Kye et al. [20] propose two technological axes associated with the metaverse, as seen in Figure 1. The first of these axes, “Augmentation versus Simulation”, refers to augmentation technology and how it adds a new visual function to the existing environment by superimposing digital information on the physical world that we perceive with our senses. On the other hand, simulation technology refers to generating and manipulating virtual models of the existing physical environment and creating virtual interactions and experiences.

![Diagram of the four types of metaverses](image)

**Figure 1.** Diagram of the four types of metaverses. Based on Kye et al. [20].

The second of the axes, known as “External versus Intimate”, refers to the visions of the world from external and internal perspectives. For the external world, the technology focuses on the users’ external environment by displaying information about its characteristics and how to control it. In contrast, the intimate world uses technology that focuses on the identity and behavior of individuals or objects by creating internal worlds of avatars or digital profiles.

The results of the integration of these two technological axes produce four types of metaverses (see Figure 1), which are detailed below [21].
• Augmented reality: This technology allows joining and combining virtual elements with physical elements in real-time. Examples: Pokémon Go, digital textbooks, e-commerce.

• Lifelogging: This technology allows us to transform the physical part of our vital signs into recordable digital elements to be easily analyzed. The most significant initiatives in this category correspond to various apps and components integrated into mobile devices capable of keeping track of heart rate, eating habits, blood oxygenation levels, and stress, among others. Examples: Apple Watch, Samsung Health, Huawei Health, and Nike Plus.

• Mirror worlds: This category includes virtual representations that are the precise vision of the physical world. Google Earth is a widely used element since it usually includes maps and geolocation sensors. Examples: Google Earth, Google Maps, Naver Maps, and Airbnb.

• Virtual worlds: These are recognized as totally immersive virtual environments in which the user enters using a character who develops an experience. With this, it is possible to interact in a “virtual reality”, in addition to playing with an identity created by the user, but in the virtual world. Examples: Second Life, Minecraft, Roblox, Zepeto.

2.3. Rules of the Metaverse

Different authors [19,22] speak about the metaverse’s seven universal principles or rules shown in simplified form in Figure 2. These metaverse rules constitute a manifesto for its future development, which are based on previously accumulated experience with the development of the Internet (World Wide Web) and are explained below.

![Figure 2. Rules of the Metaverse](image)

- Rule #1: There is only one metaverse. It is the total of all publicly accessible virtual worlds, real-time 3D content, and related media that are connected in an open global network.
Rule #2: The metaverse is for everyone. As defined by the broader inclusive social interaction rules, everyone has the same common right of entry.

Rule #3: No one controls the metaverse. It is the universal common good for digital communication and commerce, mediated as needs dictate and governed as the common interest requires.

Rule #4: The metaverse is open. It is based on interoperable technologies and tools, connected through rigorously defined and widely accepted free and open communication standards.

Rule #5: The metaverse is hardware-independent, and it is accessible from any device designed for this purpose, regardless of its type of screen or human interface.

Rule #6: The metaverse is a network, that is, a computer network that connects the world’s publicly accessible virtual experiences, real-time 3D content, and related media.

Rule #7: The metaverse is the Internet, an internet enhanced and updated to consistently deliver 3D content, information, experiences, and synchronous communication in real-time.

2.4. Layers of the Metaverse

Authors such as Radoff [23], Setiawan et al. [24], and Njoku et al. [25] divide the metaverse into seven layers shown in Figure 3. These layers represent the value chain of the metaverse, covering the technologies needed to develop it and the experiences its users expect to have. These layers can also be used to describe the conceptual segments that make up each metaverse design stage and are detailed below.

Layer 1: Infrastructure. This layer includes the technologies that power devices, allow them to connect to a network, and ultimately deliver the required content. Examples: 5G, 6G, Wi-Fi, cloud network computing, GPUs.

Layer 2: Human interface. This layer contemplates the challenge of creating the necessary tools (hardware and software) so that people can access the metaverse, that is, the elements that make their users live a genuinely immersive digital experience. Examples: smart glasses, mobile devices, and haptic technology.

Layer 3: Decentralization. This refers to the potential of the metaverse to be transparent and traceable in the interactions of its actors. Examples: Blockchain, smart contracts, open-source codes, edge computing.

Layer 4: Spatial computing. This layer refers to the development of computing in three-dimensional, temporal, and spatiotemporal spaces in geographic and non-geographical domains and its relationship with the creation of an alternative world in a digital version. This type of computing fuses immersive technologies with hyper-

• Layer 5: Economy of the creator. This layer incorporates all the technologies that creators must use daily to create and trade experiences or assets. This layer is considered the engine of the metaverse. Examples: e-commerce, asset markets, NFTs.

• Layer 6: Discovery. This layer refers to the user’s opportunity to discover and experience new experiences constantly. Discovery systems can be classified into inbound and outbound systems. In the inbound discovery system, users actively search for experience details. In the exit case, users are provided information about new experiences, whether they are looking for it or not. Examples: AD networks, social, and stores.

• Layer 7: Experience. This layer is related to users’ interaction with the metaverse in different digital environments. It refers to the continuous dissolution of physical space, objects, and distance. Examples: Esports, gaming, shopping.

3. Materials and Methods

This study is exploratory and interpretive in nature. This work is framed within a methodology based on the socio-critical paradigm. This methodology makes it possible to reflect on the applications, pros, and cons of each type of reality in order to provide knowledge to researchers and educational professionals and to apply it in the educational field [26].

The applied methodology implies a rational process through which the cognitive appropriation of reality takes place. For this conception, the logic of its method recognizes that it is dialectical, since it is a synthesis of multiple incidences and temporalities constitutive of the same subject of research. Thus, reality is a continuous process of permanent change, which can only be known through thought in the form of abstraction to be translated into a practice that transforms [27]. The logic of cognitive appropriation in the dialectical-critical method is that of discovery, since what every theoretician must do when he wants to know is investigate, in order to then scientifically explain an object. It is not a matter of testing hypotheses or verifying theoretical frameworks before investigating, since the hypothetico-deductive logic, in the best of cases, makes it possible to know the contents of the object that are already considered in the theory; what is new, what is not known, what is not theorized in this logic is unknowable because it is only verified [28]. The methodology followed for this research follows the following scheme of work:

• Construction of the research object. This is the stage in which the research concerns were defined and delimited and the cognitive requirements of these were identified.

• Construction of the research outline. At this stage, an inquiry guide was developed to express the logic of cognitive appropriation.

• Delimitation of the research object. Here the epistemo-logical cuts that the researcher makes to organize his research were established.

• Theoretical research problematization. At this stage, the problems contained in the object of study were identified, which in turn allowed it to be explained.

• Elaboration of the list of sources of information. The purpose of this phase was to determine which and what type of sources were needed to construct the knowledge being investigated.

• Design and execution of the work plan. The purpose of this stage is to program the activities and tasks to be carried out during the research process.

In this approach, the researcher strives to understand the phenomenon and experiences around the concept of the metaversity. The focus is on the social construction of reality, and the researcher seeks to understand the world through the information collected through qualitative analysis. The paper also aims to explore the concept of the metaversity in depth and identify any relevant factors that should be investigated further. The research was conducted between August 2022 and March 2023. The WoS, Scopus, and Scielo databases were used as the main sources of information. Articles published in journals and
proceedings that have reported on the use of the metaverse in education were included. Other types of works such as books, workshops, and any irrelevant literature or literature not related to the metaverse and education were excluded.

During the exploratory research, a series of procedures were carried out to obtain detailed results. First, the topic of study was identified, and then the problem to be investigated was addressed through the guiding questions (RQs), designed to generate answers adapted to the reality and context. Second, exploratory research information was collected from primary sources. Third, through qualitative research, the author answers the guiding research questions.

4. Results

4.1. RQ1: What Are the Main Technologies and Applications Trends of the Metaverse in Universities?

A brief search in the Scopus database for the keywords “metaverse” and “university” shows the boost in scientific production. From the point of view of the literature reviews that address the use of the metaverse in universities, Table 1 shows the main objectives ordered by the number of times cited in each study, which serves to provide a first approach to a state of the art about the topic.

Table 1. Characteristics of top papers found in quick search.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Main Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrigna and Musumeci [29]</td>
<td>Review the current literature for articles that connect the metaverse to health prevention and treatment, education, training, and research.</td>
</tr>
<tr>
<td>Iwanaga et al. [31]</td>
<td>Understand metaverse specialists and their implementation for anatomy education and provide ways forward for using such technology in this discipline.</td>
</tr>
<tr>
<td>Abbate et al. [32]</td>
<td>Review studies on the metaverse using bibliometric analysis in order to provide a comprehensive overview of the expected impacts on industry and society.</td>
</tr>
<tr>
<td>Jauhiainen et al. [33]</td>
<td>Examine how academic discussion and research on the metaverse developed from the 1990s to the end of 2022.</td>
</tr>
<tr>
<td>López-Belmonte et al. [34]</td>
<td>To analyze the existing research on the metaverse in education through a systematic review of the literature.</td>
</tr>
<tr>
<td>Almoqbel et al. [35]</td>
<td>Conduct a systematic literature review of articles that used and defined the term metaverse.</td>
</tr>
<tr>
<td>Far et al. [36]</td>
<td>Identify new applications of NFT in the metaverse as well as its future directions in the application of NFT in industry and academic research.</td>
</tr>
<tr>
<td>Maheswari et al. [37]</td>
<td>Provides a systematic review of the literature addressing the integration of the Internet of Things into the metaverse for an improved learning experience.</td>
</tr>
<tr>
<td>Alfa faisal et al. [38]</td>
<td>Systematically evaluate metaversal research in education from a theories/models point of view to provide a comprehensive pointer that could help scholars conduct additional research in its acceptance.</td>
</tr>
<tr>
<td>Al-Ghaili et al. [39]</td>
<td>Disclose articles related to the metaverse, providing a review of the chronological stages of its development throughout history, as well as the technological advances that allow its implementation.</td>
</tr>
</tbody>
</table>

Table 1 also shows that most of the studies that relate to the metaverse and the university focus only on the use of immersive technologies in the classroom. The research presented here addresses, in solitary form, processes other than pedagogical activities. Current research does not integrate the activities that are commonly performed in higher
education institutions, which opens the opportunity for new developments in this field, such as the concept of the metaversity that will be explained in a later section.

Alternative databases host other systematic reviews in this regard, such as Sarıtaş and Topraklioğlu [40], who want to examine and analyze the changing understanding of the use of the metaverse in education over the years to contribute to future research, managing to determine the opportunities and risks that teaching in the virtual environment can offer to the field of education. In addition, Tang et al. [41] carry out a systematic review to identify the application, areas, recipients, didactic contents, evaluation methods, and performance of immersive technologies (VR, AR, Mixed and Extended Reality) in medical practice and education. Universities around the world can be expected to evolve their physical campuses into virtual campuses in the metaverse in the not-so-distant future. Some pilot experiences are already underway, such as Tec21 of the “Tecnológico de Monterrey” in Mexico [42].

The advances in the development of immersive technologies, the appearance of instantaneous communication through 5G networks, and the development of virtual modeling software allow the creation of sophisticated three-dimensional graphics, which achieve the design of avatars that can express the inner “I” of the user. The creation of hyper-realistic environments or scenarios is the perfect support to immerse the end users of the metaverse in a reality created with the help of computers but with the potential to be a virtual twin of reality. Additionally, allowing multiple users to access virtual platforms simultaneously enables real-time interaction among its participants, contributing to constructing the formative metaverse. It is a virtual space in which the didactic methodology is applied. That kind of pedagogical methodology is called immersive learning [43], whose benefits are something universities should take advantage of as a new resource or training complement.

Navarro and Zabala [44] express that there is a paradigm established in the educational sector that presumes a perceptive barrier of isolation in the users of immersive education, which makes up an erroneous pre-conception, which must be repealed to establish this type of pedagogical strategies in open and collaborative educational environments mediated by telepresence. The novelty of this type of technological tool, coupled with the particular expansion of cyberspace and the new areas of virtual coexistence of digital natives, should motivate academics in the short term to develop and study experiences of this immersive education and its implications for students, teachers, and other actors [45].

Immersive technologies have recently received special and growing attention, driven by the implementation of ERE, the preceding in terms of the development of various applications and research aimed at determining the impacts, in different dimensions, of this new tool as a support for the pedagogical process, to achieve learning outcomes in different subjects and at different educational levels.

Several investigations have validated the use of immersive technology and the metaverse as the new constructivist teaching scenario in the post-pandemic era [46], given that it is an active methodology that promotes more excellent retention of information and meaningful learning [47], giving rise to a new pedagogical trend called immersive learning, which refers to the cognitive states that affect learning during activities within virtual environments designed for this purpose [48].

4.2. RQ2: What Does the Metaversity Mean in Higher Education in the Post-Pandemic Era?

Currently, there is a concept that involves the metaverse and the university but that goes beyond the use of immersive technologies within the training process rather encompasses the entire university ecosystem. This concept is known as the metaversity [49]. It is easy to deduce that the word metaversity comes from the fusion of the words metaverse and university, but as mentioned above, its concept exceeds the implementation of immersive learning in classrooms; it involves the creation of a virtual meeting point that puts it in contact with all the actors that make life within a higher education center, such as teachers, students, researchers, administrative staff, and other interested parties. In a metaversity, all these roles and functions are fully exercised, and digital twins represent or reproduce
the physical infrastructure and pedagogical resources. The metaversity comes to be one of society’s initial steps toward what is expected to eventually become an entire global metaverse [50].

Ideally, in a metaversity, a virtual university campus can be experienced at your own pace, which is unlike the typical administrative processes such as student registration, payment of particles, consultations with directors and professors, or pedagogical processes such as teaching undergraduate and postgraduate students, as well as research and social interaction, and even playful or recreational activities. All these instances would be enhanced by the advantages of virtuality and new immersive technologies, such as the use of learning objects modeled in three dimensions (human organs, artifacts from history, molecules, mechanical structures, etc.).

In a metaversity, traditional classrooms can be replaced by specialized learning classrooms focused on the particular theme addressed, such as a spaceship, an island of dinosaurs, an art history museum, and even a nuclear power plant, where the student can interact in a safe and controlled way with the added virtual elements, visualizing physical phenomena that resemble the real ones. The classes taught live by the teacher can be recorded and saved in a content repository so that they can be accessed and experienced by the students when they consider it necessary.

The metaversity and the platforms that support it can work with technological tools other than immersive ones, such as (1) Big Data for data collection, (2) Artificial Intelligence and/or Machine Learning for data analysis and decision-making in real-time, (3) the Internet of things for connection at all times and anywhere, and (4) the blockchain for user identification and electronic commerce.

Another important feature of the metaversity is that it can be geographically agnostic, that is, students meet with their professor, other students, or some institutional official, even if they are physically hundreds or thousands of kilometers away. While metaversities are best experienced through virtual reality or augmented reality headsets, they can also be accessed through a typical desktop computer, or mobile devices (smartphones, tablets, or laptops) providing greater accessibility for your users. A related concept is the one coined by Costanza et al. [51], called “MetaUniversity”, which refers to a collaborative consortium of universities and other educational institutions that provide quality education at a lower cost, whose purpose is the sustainable well-being of humanity.

Given the novelty presented by this concept of the metaversity, this research aims to bring together the various advances made through an approximation of its state of the art to analyze the scientific evidence found to detect the gaps and challenges in its implementation.

4.3. RQ3: What Are the Main Problems Associated with the Use and Implementation of the Metaversity for Higher Education?

The emerging character in the application of the metaversity detected in this document opens the doors for the many questions that still do not have a firm answer. Many of the barriers that the metaversity will have to overcome are inherited from the immersive technologies themselves and the implementation of the metaverse. Issues associated with scalability, accessibility of XR devices, and the struggle between multiple metaverses are some of the more general ones. All of these coincide with the six fundamental pillars for creating the metaverse ecosystem proposed by Lee et al. [52] and in the eight technologies in which they are leveraged. All these pillars and technologies are based on and supported by the human resources that develop and use them, as shown in Figure 4 and described below.
4.3.1. Avatars

Avatars are a fundamental part of the metaversity, as they allow users to digitally represent themselves in this immersive environment. Although current technology could capture the characteristics of the user’s physical appearance and generate avatars automatically, mobile sensors are not yet fully developed, which limits the ubiquitous aspect of the metaversity and its use in real-time. Additionally, for avatars to be more realistic and effective in the metaversity, further efforts are required to improve aspects such as capturing micro-expressions and nonverbal expressions of avatars. These details are crucial to make the user experience more immersive and closer to the natural interaction they would have in a physical environment. It is also essential to work on optimizing the interaction between avatars and current smart devices. This would allow for greater integration and fluidity in the use of the metaversity on different platforms and devices, thus facilitating its adoption and access for a wider audience [13].

4.3.2. Content Creation

Content creation in the metaversity is limited to design professionals, which affects its universality. To address this, it is essential to research and develop platforms that allow all stakeholders to participate in the co-design of this digital universe. More intuitive and accessible tools would foster inclusion and diversity in the metaversity, enriching the experience for all users. Open collaboration and equitable access to design tools will drive creativity and innovation in this shared virtual environment [12].

4.3.3. Virtual Economy

Although cryptocurrencies have proven their usefulness in terms of efficiency and security in digital transactions, they still face challenges in their integration with the traditional economy. The lack of a solid infrastructure to facilitate the smooth exchange between virtual currencies and other types of currencies are obstacles that need to be overcome. Widespread understanding and acceptance of cryptocurrencies in various sectors of society is still in its early stages. All of the above must be achieved for a
more complete transition to the virtual economy. It is important to continue working on developing solutions that allow for a gradual and harmonious transition between the two economic systems. The creation of bridges and platforms that facilitate the easy use of cryptocurrencies in everyday life will be fundamental to driving a wider, faster, and more successful adoption [53].

4.3.4. Social Acceptance

For the metaversity to consolidate and thrive, it is essential to consider the collective judgments and opinions of its main stakeholders in the educational arena. The inclusion of these perspectives is vital to ensure that the metaversity meets the needs and expectations of all stakeholders. The lack of research in this area may present challenges to the widespread adoption and acceptance of the metaversity. Understanding the concerns, preferences, and desires of stakeholders in the education ecosystem will address their concerns in the transition to the metaversity. These new technologies must be tailored to the dynamics and culture of each institution, as well as to their specific audience. This will ensure that the platform reflects the needs of the educational community and fosters a more inclusive and enriching experience for all users [54].

4.3.5. Security and Privacy

To ensure the future viability of the metaversity, it is imperative to design strategies and technologies that address cybercrime and protect digital assets. While there has been progress with the use of the Blockchain, further development is still required in terms of identification, interfacing with the Internet of Things, and wearable devices. Collaboration between cybersecurity experts, researchers, and developers will be essential to ensure a secure and trusted virtual environment in the metaverse [55].

4.3.6. Trust and Responsibility

One of the critical aspects of the metaversity is the treatment of user data that may be collected by platforms, such as biometric data. Current research has not been able to define a framework based on ethical principles that can define/regulate the privacy of personal data at the same pace in which technological innovations are developing. Future studies should address issues such as minority rights, vulnerable communities, or socially sensitive issues as the metaversity evolves [56].

4.3.7. Mental and Physical Health

There are few scientific data on how the use and implementation of the metaverse and other immersive technologies affect the physiology of the human body as a risk factor for prolonged use. The health and well-being of individuals should be a priority in the development and promotion of the metaversity. Only a sound scientific basis and a responsible approach to their implementation can ensure that these technological innovations are a safe and beneficial tool for society at large. The scientific community and health professionals must work together to conduct rigorous research to identify potential risks and develop preventive measures and usage guidelines that minimize adverse effects on users [57].

In general, the future of the university through the establishment of a metaversity undoubtedly requires further development in each of the points shown in Figure 4 but also in others that are equally or more important, such as the physical effects and psychological effects on users of the intensive use of this type of technology, the consequences for societies due to its massive use, as well as its carbon footprint.

5. Discussion

Many authors predict the success of the metaverse in the economic, social, and educational spheres and its positive repercussions on people’s daily lives [58,59]. The current literature shows different proposals and experiences in areas such as health [60], manu-
facturing [61], maintenance [54], smart cities [62], gaming [63], entertainment [64], commerce [53], human resources [65], real estate [66], financial services [67], public services [68], transportation [25], tourism [69], and vocational training [70]. The metaverse has managed to transform the gaming and entertainment sector [30,31], as shown by the platforms Roblox, Minecraft, the World of Warcraft, and Second Life. The above platforms are only one type of metaverse, which are just one type of metaverse among others and that are usually supported by a specific type of technology, the immersive ones [32]. In this type of technology, the real world is simulated through virtual elements, and it is an example of how people's telepresence can be made possible. The use of the metaverse can often overcome physical limitations, cultural characteristics, or the absence of specific spaces and equipment, but where it is the reality, it would be impractical or precarious to carry out different activities continuously [33].

On the other hand, authors such as Kye et al. [9], Xi et al. [34], and Choi [24] have come to predict that the metaverse will bring substantial changes in the daily life of people and even in the economy of countries. The metaverse has the almost infinite potential to be “the” new space for social interaction. All of the above is of special attention and relevance for the educational sector since it gives this type of technology the ability to transform it, making it possible to overcome limitations and deficiencies left by ERE. The metaverse could become an ideal platform for the post-pandemic period.

The implementation of the metaverse offers many opportunities but also generates many questions and issues that are still under development. This research delves into a new concept called metaversity. An attempt is made to group metaverse applications around higher education by encompassing beyond immersive learning in the formative process of students. The findings suggest that there are no experiences that encompass the full implementation of the metaversity but rather the development of very close approximations and innovative experiences in several of its main aspects. This incipient state at the level of research is to be expected, given that the metaverse is still in an emerging stage. The technologies necessary for its full implementation are still in development, which makes all those studies from previous decades mere projections of the near future. The publications closest to the concept of the metaversity were related to the implementation of digital twins on university campuses and the experiences of providing university services. The metaversity still presents many unfinished and/or developing technical issues, such as ownership, accessibility, interoperability, security, and social acceptance. However, the interdisciplinary nature of the metaversity brings to the fore many other points, which also constitute an excellent opportunity for the researchers.

Current developments in information and communication technologies move the metaversity away from being a utopian concept and closer to a possible reality. High-fidelity photorealistic simulation platforms like the one developed by Nvidia called Omniverse, whose main feature is integration with cutting-edge technologies and infrastructure, often require an implementation framework that provides a high-level programming abstraction and large-scale modeling. Technologies such as Artificial Intelligence/Machine Learning, digital twins, and photorealistic visualization make possible the development of metaversity experiences. A correct connection with the main software used today by the immersive experience creation industry (Unreal Engine, Blender, Autodesk, ParaView, etc.) and its ability to import real scientific models and data are also necessary.

Significant economic impulses from private companies come to ensure the future viability of this type of platform, such as the project proposed by Niantic. This company created Pokémon Go, which proposes the creation of a global 3D map that allows developers to anchor digital content to the actual physical world through its Lightship platform. Experiences such as the one proposed by the NFL, Roblox, and Warner Music Group, who agreed to hold the virtual Super Bowl concert in the metaverse (called Hythm City), which is expected to be an immersive social music-themed experience. Acquisitions such as the one made by Microsoft for USD 68.7 billion by the video game company Activision Blizzard, with which they hope to boost the development of their metaverse platform, Mesh.
Just as the metaverse inherits the benefits of the metaverse, it also inherits its problems, many of which are associated with the implementation process of any disruptive technology. The resistance to change, the particular tastes, or the personal concerns of its users can affect its execution on a large scale, especially in the academic world, where the adaptations of the internal processes of educational institutions are always a complex issue.

On the other hand, privacy, and the physical and mental health of users, are also critical challenges to solving the metaversity so that massive or large-scale experiences can be developed. Although the Blockchain has been shown to protect users’ privacy and solve the first of these challenges [71], the problems associated with health due to the use of immersive technologies deserve special attention. The appearance of emerging pathologies associated with musculoskeletal or visual disorders, as well as sleep problems, the risk of being overweight, and a sedentary lifestyle have been documented in the scientific literature [72–74]. In addition, problems such as addiction, behavior, technophobia, or affection to interpersonal relationships could also be familiar with the use of the metaversity [75–77]. Recent research addresses the so-called “cybersickness”, a term used to define a series of discomfort symptoms (disorientation, nausea, eye fatigue, etc.) experienced by some users of immersive technologies, but studies on this subject are still inconclusive [78,79]. Other authors state that the psychosocial problems presented by users of this type of technology are most often due to pre-existing pathologies [80].

The implementation of the metaversity requires the continuous use of immersive technologies by students, teachers, administrators, and other users, which can only be achieved with a strict system in the process of adaptability and monitoring of adverse effects. Gradual and progressive use for large-scale implementation should be completed just like other professions that affect sensory systems. Seafarers, workers at heights, and pilots of land, sea, and air vehicles are examples of professions that, in their initial practice, may have started with motion sickness symptoms. People with this type of professional work, after a process of adaptation, achieve an acceptable level of tolerance, without any type of affection to their physical or mental health. In spite of the above, scientific evidence shows how the simple use of these platforms presents tangential benefits such as the training of attention and working memory functions, and of their neuronal mechanisms that underlie possible cognitive improvements [81].

The massification of the metaversity could also bring about other problems, such as increased pollution due to the large volumes of energy consumption or those associated with its governance. The latter, enhanced by the lack of clarity of the scope of the metaversity, practically makes it impossible to create internal regulations for universities and laws by states and governments, which could be considered necessary to ensure the responsible use of immersive technologies and their relationship with the social life of people. So, for now, anything said about specific laws in the virtual world is just gambling. Currently, the metaverse and the metaversity are cumbersome and challenging issues for any current ruler, and the treatment of Bitcoin by some states can be seen as an example, as some consider it legal tender and others prohibit it, but the substantial remaining majority does not know what to do with it.

The implementation of a metaversity also involves the formation of new digital citizens, where the awareness and implications of the users are developed. In the implementation of a metaversity, teachers play a decisive role in their correct transition, highlighting these vital elements, activating debates, providing spaces for activities and reflections and making reasoned choices about the use of platforms and devices, motivated by real training needs, based on fundamental ethical principles [82].

The integration of immersive technologies in the daily lives of people seems to be a path taken by large technology companies, and its widespread use is becoming more and more a fact. However, its use and implementation will be gradual, giving time to overcome many of the challenges that the implementation of this type of technology is expected to bring. In the universities, the deficient technological platforms and the low digital skills of students, professors, and other actors were problems evidenced by the pandemic and
are a sign of what will have to be overcome for the adoption of a metaverse ecosystem in higher education institutions. The implementation of the metaversity could widen the gap between those who have more resources and those who have fewer, so universities must ensure the proper creation of new educational scenarios [57].

6. Conclusions

The present study intended to analyze the characteristics of the research related to the concept of the metaversity, where its great potential and its benefits for higher education were evidenced, but it revealed its incipient nature. The replacement of the natural world by a metaversity seems not to be as close as the enthusiasts of this technology would like. However, the level of its current development gives the ability to virtualize in real-time those details that give the perception of reality (facial expressions of people, their gestures, eye contact, and even physical contact). Even though emerging technologies always have the potential to improve the teaching–learning process, it should not be forgotten that in the end, it is the teacher who must design educational experiences using the resources that best suit the context and capabilities of those involved.

The metaversity is an umbrella concept that encompasses the use and implementation of digital, immersive, and emerging technologies (such as virtual and augmented reality, Blockchain technology, the Internet of Things, digital twins, etc.) within universities. The metaversity aims to be a space for social and professional interactions between all higher education stakeholders.

The metaversity is a technically feasible concept, but it must be designed considering a methodology that involves coming to know all the actors involved in the higher education ecosystem. Accessible and flexible content must be developed. The weaknesses of human resources from the point of view of developers and users should be approached with caution. The constant need for the training of professionals, and the physical and mental health problems derived from the use of the metaverse, is evidence of the above.

Although the metaversity still needs time for its successful implementation, at least for its massive use of real-time and interactive 3D environments, some initiatives associated with the educational metaverse are already available today. It is expected that in the near future, many more experiences will appear in the coming months and years, as the technologies mature.

The metaversity is proposed as a new educational scenario whose main tool is immersive technologies. The metaversity opens the door to new possibilities for teachers to overcome many of the current barriers to learning. Its implementation could benefit students with different types of disabilities, since personalized activities could be designed according to their needs and will be enhanced by digital natives, those students born in an environment where digital devices have been within their reach since birth. This new generation of students will be accustomed to the coexistence between the virtual world and the physical world.

The rise of the metaversity in the post-COVID era should stimulate the level of academic debate on its impact on society. The emergence of new and exciting challenges related to governance, ethics, security, and acceptable behavior privacy, should stimulate scientifically rigorous research. The sustainability of the metaversity as a new learning ecosystem in higher education should be the main focus of efforts among all stakeholders.

The present study had several limitations. The first is that it is limited to only three databases (WoS, Scopus, Scielo), which despite being the ones mainly used in the scientific world, several others can also be consulted by researchers. Second, the type of document consulted was restricted to scientific articles, conference proceedings, and systematic reviews, leaving aside other types. Third, only documents in English and Spanish were included.

Considering that the components and architecture of the metaversity have not been fully developed and applied, future studies can address the contributions of the metaversity to learning processes through educational simulations and learning environments for
students with disabilities or special difficulties. Perhaps one of the most relevant aspects to be studied is how the whole teaching–learning process will take place.

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