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Metaverse Framework: A Case Study on E-Learning Environment (ELEM)

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Abstract: Metaverse is a vast term that can contain every digital thing in the future. Therefore, life domains, such as learning and education, should have their systems redirected to adopt this topic to keep their availability and longevity. Many papers have discussed the metaverse, the applications to run on, and the historical progress to have the metaverse the way it is today. However, the framework of the metaverse itself is still unclear, and its components cannot be exactly specified. Although E-Learning systems are a need that has developed over the years along with technology, the structures of the available E-Learning systems based on the metaverse are either not well described or are adopted, in their best case, as just a 3D environment. In this paper, we examine some previous works to find out the special technologies that should be provided by the metaverse framework, then we discuss the framework of the metaverse if applied as an E-Learning environment framework. This will make it easy to develop future metaverse-based applications, as the proposed framework will make the virtual learning environments work smoothly on the metaverse. In addition, E-Learning will be a more interactive and pleasant process.

Keywords: metaverse; E-Learning; learning environment; metaverse architecture; digital twins; clouds-based applications

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Citation: Dahan, N.A.; Al-Razgan, M.; Al-Laith, A.; Alsoufi, M.A.; Al-Asaly, M.S.; Alfakih, T. Metaverse Framework: A Case Study on E-Learning Environment (ELEM). *Electronics* **2022**, *11*, 1616. https://doi.org/10.3390/electronics11101616

Academic Editor: Christos J. Bouras

Received: 28 April 2022
Accepted: 16 May 2022
Published: 19 May 2022

1. Introduction

Internet is the primary technology in this era that drives people to replace their reality with its representatives [1]. According to Duan et al. [2], the most recent version of the Internet is the metaverse, which is also the hottest topic nowadays that started its existence with the blockchain. However, it has needed more than 30 years to reach its current prominence [2]. Stephenson [3] and Lee [4] defined the metaverse as an immense 3D virtual environment parallel to our physical world, where users can interact using digital avatars, i.e., virtual reality is the future dimension of technology [5]. However, Parisi stated that the metaverse is a vast world that can include everything inside its components and layers [6]. As the metaverse has become the hottest topic recently, academic and industrial journals massively cover and still dig into the realities of this new topic.

In the literature, Damar noted few studies in the historical process for the metaverse, because, as he described, its vogue has recently peaked and been applied widely via virtual and augmented reality technologies [7]. However, none of them can give us a complete view of what the metaverse is, its components, and its requirements. Moreover, as academic papers cannot assume any information without solid proof or an acceptable explanation about where it came from, the best we found were some blog topics by Parisi and Radoff on the Medium website. Rodoff divided the metaverse into seven layers, including infrastructure, human interface, decentralization, social computing, creator economy, discovery, and experience [6,8]. This division is amazing and covers many things, as it shows to which layer an application belongs, but it puts the metaverse technologies in a single layer, while the applications are separated in the three above layers. The layers are provided as rules to govern the interactions between the layers; the real user and the avatar are not mentioned, and neither are the digital twin and mirror world.

Due to the quarantine of COVID-19, the metaverse has provided the ability to run off physical time and space limitations, using non-face-to-face services [9]. The metaverse can be used successfully by E-Learning (we use the term e-learning to denote the educational and learning application types, i.e., E-Learning, M-Learning, Blended Learning, Virtual Learning, Distance Learning, and Online Learning) as a solution for the subjects that depend totally on convergence and cannot be taught online or in distance learning, such as medical and engineering courses. Although E-Learning environments have many different types [10], metaverse-based systems can also be used to provide safe and efficient environments for education and business by applying virtual reality technologies and continuously studying and endeavoring to expand learning experiences [11]. As a result, in the metaverse, all known learning systems will depend on the virtual learning environment (VLE). In addition, the metaverse is not just a virtual reality (VR) environment, but it also merges the Internet and web technologies and extended reality (XR) [10,12]. Smart et al. [13], stated that the roadmap of the metaverse consists of four parts that are augmented reality, life logging, mirror worlds and virtual worlds. These four parts are divided according to four dimensions, which are external, augmentation, intimate and simulation. What is more, simulation is the essential part that provides either a mirror of the physical world or a complete virtual world for the physical world [13]. Users can directly or indirectly experience, store, and match E-Learning keywords with any content made 3D via their mobile devices to analyze or experience content and provide customized services to users based on the metaverse without restrictions of time and space [9].

Akour et al. [14], stated that "the metaverse is a kind of imagined world with immersive digital spaces that increases, allowing a more interactive environment in educational settings. It is an expansion of the synchronous communication that embraces an effective number of users to share different experiences". In their study, they used an artificial neural network (ANN) to analyze users' intention to use the metaverse in their daily used applications [14], but no more analysis for the metaverse framework itself. Zhu developed a metaverse framework based on multiscene relations and an entity-relation-event game. As a result, MetaOnce focuses on how to enrich relation types between entities and events by building multiscene graphs. MetaOnce was introduced because, according to Zhu's perspective, there is no portable framework to introduce rich concepts, relations, and events into the metaverse [15]. Although it is supposed to be a metaverse environment, its structure is no different from any AI-based games, with no use of the new terms of technologies related to the metaverse or any operation-related components. Zhu also [16] used their previous work to highlight the need for artificial intelligence (AI) in any metaverse framework. They added the digital twin with natural language processing (NLP) to their previous framework. According to their perspective, any metaverse-based application is essentially used in one of three scenarios: hardware and software support, smart devices, and content editing. They also specified various famous modern metaverse-based applications which depend on specific techniques, such as content editing, smart devices, VR, AR, blockchain, digital twin, XR, cloud computing, and avatars, which can be used one at a time or in groups that collect as many techniques as needed [15,16]. To the best of our knowledge, to use a new technology in the perfect way, we should use all or a sizable number of its techniques to gain the most benefit of this new technology. However, the available applications use three, at most, of the metaverse special techniques, which means that all the available applications are just demos or test applications to help emphasize the ability of the company or researchers to develop metaverse-based applications. Duan et al. [2], divided the metaverse framework into three layers. The first is the infrastructure layer, which denotes the physical world. Then, the interaction layer between the physical world and the virtual world. Finally, the ecosystem layer represents the virtual world [2]. This framework is modern but abstract and does not provide any details about what does each layer contains. Moreover, it applies only to virtual reality without the other three dimensions of the metaverse roadmap mentioned by Smart [13].

In this paper, the author discusses some of the available frameworks of virtual learning environments that are developed to be run on the metaverse. This study aims to investigate the components of the metaverse framework that are needed to run any type of application. Next is a discussion of how people can deal with the applications uploaded on metaverse. The resulted framework is used to propose a new framework for any E-Learning environment, based on its compatibility with this new technology. In the rest of this paper, we demonstrate a part of the previous pieces of research in Section 2. Section 3 shows the proposed framework. Section 4 discusses this framework and then explores some challenges in Section 5. Section 6 concludes this study.

2. Previous Frameworks

As a new environment, any proposed learning environment should be learned first, and it should also be easier to learn with. As a result, many of the proposed applications are in either in the educational, or gaming field. There is a set of research that focuses on proposing virtual learning environments. Some of these papers suggested a way to measure students' self-regulation which uses specific systems as virtual learning environments [17] or gain communicative and cooperative competencies to qualify them for their professional work and their role in society [18]. However, these research groups did not propose any environment; instead, they only used available systems and checked the students' performance and cooperation. The frameworks of their proposed systems were not included in their research papers. Some other research groups proposed virtual learning environments, such as the collaborative learning environment of Ma. Ma's collaborative learning environment is a client–server environment that does not support virtual reality [19], but it may send results to the user with 3D modeling. Some other researchers developed supportive systems as Nasereddin does with their private cloud computing framework to support E-Learning environments. They described the developments in cloud computing and proposed five layers for it, all at the same level with different considerations [20]. However, none of these research papers connected their proposed models or adapted them to the metaverse.

On the other hand, Duan et al. [2], with the start of the blockchain era, studied how the new era of the metaverse started and that it should have enough consideration to keep up with the technology. However, it is still in its infant stages [2]. They stated a brief timeline of the metaverse development. As the core of the metaverse technologies, the blockchain is used as a decentralized, core functionality needed by any system on the metaverse. In their research, they specified the metaverse framework by drawing two vertical circles, overlapped to make three layers: the physical world or the infrastructure (bottom), interaction (middle), and the virtual world (top). They used the blockchain as the infrastructure unit and then questioned the computational power without solving those questions. Although this paper proposes the framework of the metaverse, it is not capable of implementing the E-Learning system because it is very plain and abstract. Moreover, though they mentioned the Chinese University of Hong Kong, Shenzhen (CUHKSZ) metaverse as the campus metaverse prototype of the Chinese University of Hong Kong, Shenzhen, it is just a social system, not a learning environment. Its basic framework is how they distribute the supportive apps and solutions among their proposed framework of a metaverse in the three layers. Furthermore, their social system helps in keeping the university clean and guides the directions, not to solve questions or provide different levels of interactivity.

The proposed work of Ariyadewa et al. [21] is a 3D hypothetical online domain, where students can connect and interact with each other and with the 3D learning objects. It combines 2D and 3D environments. Their model stated that the 3D environment could not complete its process without having a combined 2D environment as a feeding resource. In addition, the 3D environment consists of three components: contents including the physical world and perceptions, the course materials, the approach that provides the learning means and embeds knowledge and personalizes learning, and the evaluation materials to test the students and merge some evaluation methods from current applications with modern ones to evaluate students [21]. However, they did not provide a single note about the metaverse framework itself or how it deals with virtual reality and its application. They focused on the mechanism to show the 3D results by the E-Learning environment based on a database like a 2D environment, illustrated the 3D part, which consists of contents, approach, and evaluation, ignoring the details of operating the 2D environments and those needs. As a result, this framework is too far from the reality of the metaverse. Moreover, the metaverse in its modern implementation does not need to depend on specific hardware, let alone the 2D environment.

Xu et al. [22], introduced the double Dutch auction system to study the economic system of the wireless edge-empowered metaverse for VR services. This system achieved effective and efficient performance in terms of social welfare and auction information, exchanging costs with various system settings [22]. Nevertheless, they added the metaverse as a small part of the proposed system. Subsequently, the metaverse should include all the parts of the proposed framework because virtual reality is a core part of the metaverse. Moreover, they focused more on operating the system efficiently than the layers of the framework itself.

Jovanović et al. [23], introduced a high-level software architecture for a safer metaverse platform, primarily designed to support collaborative learning activities with the virtual learning environment (VLE). It uses a modern technology stack and metaverse concepts [23]. Yet, their architecture depends on virtual reality only. In addition, the metaverse depends on augmentation, lifelogging, and the mirror world [13], not just the virtual world. The physical part of the system, as well, is completely missed. The 3D-virtual learning environments of [24] is a theoretical framework that consists of three parts: users, external environment, and 3D virtual learning environment. The 3D-VLE consists of a physical, social, and normative environment and a virtual learning community. The virtual learning community includes only the avatars that simulate the users in the virtual world, connecting with them using the VLE application interface to deal with the other environments. However, this framework did not mention or explain any of the virtual world or reality's applications or mechanisms.

To change the educational systems to Society 5.0 which is based on the IoT to share knowledge, Suzuki et al. [25], proposed an educational system based on metaverse to achieve establishments of a VLE. They depended on various 3D objects and IoT in the first place [25]. However, it is just a theoretical perspective and has not been implemented yet; additionally, it uses only2some of the metverse techniques. Han et al. [26], used a group of IoT devices operated on their metaverse platform to collect real-world data on behalf of virtual service providers (VSPs). In their perspective, the metaverse consists of four component: interface, cross-word ecosystem, infrastructure, and in-world ecosystem. The first three components connect the physical world and the metaverse, and the last one represents the metaverse as they are financing, non-fungible tokens (NFT), and user-generated contents (UGC) [26]. Their description of the metaverse is amazing but they divide the metaverse special techniques into two components, where one of them represents the metaverse itself and the other is used as one of the interacting components, which contradicts the definition provided by Parisi in [6]. In addition, they did not provide any reason about why they had to separate the components into two groups, while they are all provided by the metaverse. Nguyen et al. [27], proposed a blockchain-based framework for metaverse applications. Their framework consists of three layers that are interactions to describe the users interaction, granting access and contributing resources, blockchains to share data blocks between providers and companies, and the applications that users use and should run on the metaverse framework [27]. Although they applied this framework using the blockchain and started using it, the infrastructure and any other technology of the metaverse are not mentioned at all, which make it hard to determine whether this framework can operate the various metaverse-based applications. Lim et al. stated that "we are still far from realizing the vision of a seamless, shardless,and interoperable Metaverse given the stringent sensing, communication, and computation requirements". Thus, they proposed a metaverse architecture that consists of two sections. Section A part 1 is both the virtual world and the physical world. The virtual world provides an avatar, virtual environment, virtual goods/services, and tangible goods/services. The physical world manages the user, IoT/sensors, virtual service provider, and physical service provider applications. Section A part 2 is the metaverse engine that provides VR/AR, haptic, digital twin, AI, and blockchain. Section B is the infrastructure for communication, computation and storage [28]. This architecture is well explained and describes the interaction between sections with good details. However, no interaction mentioned between Sections A and B, IoT/sensors, is part of the infrastructure but is mentioned with the physical world, and although the virtual world is a part of the metaverse special technologies, it is separated from the metaverse engine. Furthermore, if the whole architecture is for the metaverse, we should ask why the metaverse needs an engine to operate it, and why this engine is in a separate section if the metaverse needs a powerful infrastructure to operate all the needed tasks. Boschert et al. [29], described the uses of digital twin in the mechatronic systems to combine the physical and virtual worlds in all life cycle phases using simulation [29]. In this chapter, the writers described many scenarios to employ simulation and digital twin for many mechatronic tasks, but the metaverse is not only these two.

Here are also some educational systems that employ great functionalities but without the metaverse. Heath et al. [30], developed Numina, a mobile learning environment that has a well-described architecture, starting from servers and their protocols and services, followed by the development environment of lessons and learning applications, ending by the virtual learner communities that obtain the learning services from the servers and the development environments [30]. Al Sulaimani et al. [31], developed an interactive learning environment to enhance lecture interaction. Both the teacher and student should log in to the system, which consists of many units and functionalities to provide the highest level of interaction [31]. Both these two research papers discussed two important aspects of the E-Learning environment, and neither of them adopted the metaverse. Swart studied the behavior of students toward the open distance learning environment [32]. As all students will be asked to study via the metaverse, still many students cannot access the internet from their homes. Karacan et al. [33], reviewed the state of the art for using augmented reality (AR) as a supportive tool for foreign language education. They also stated that AR has many benefits for language learning but it is still not ready to be integrated into language classes, as it is not specifically designed for education and it does not completely fit with a certain learning theory [33].

3. Metaverse Framework and the Proposed Framework of E-Learning (ELEM)

The virtual learning environment is the primary environment for future educational systems. Caring for such systems is very important to ensure the future of the next generations. Therefore, adopting new but challenging technologies is essential to make the E-Learning environment full of fun. It also provides a complete and effective educational process. As a result, researchers and developers need to know how the metaverse is operated and what is included in the metaverse as its special technologies. Although many researchers have proposed the layers of the metaverse framework or architecture, there is no consensus about its layers, the count of the layers, or what should be included in a layer and excluded from another. Moreover, although there are many proposed systems to work on or with the metaverse, these applications do not receive the full benefit from using the metaverse. Thus, we describe the framework of the metaverse according to the best of our knowledge and the research papers we collected, and then we show what will represent each layer in the proposed virtual learning environment, ELEM.

ELEM is the proposed framework according to the notes collected from the literature review. ELEM consists of a user, some—as needed—devices, and metaverse components that consist of the infrastructure, the avatar, and the metaverse special technologies. Here is an explanation of each of them:

- According to Figure 1, the first- and endpoints are the user (a teacher or a student) who interacts with a device.
- Any user who wants to use a metaverse-based application should start from the app or interface connected to the metaverse. The app or the interface will work as the gate to the metaverse, which may have another form of technology in the future.
- The system will cause some reactions that users can sense by touch, sight, sound, and possibly also by smell in the future. All these reactions need special receptor devices to provide their senses to the user. As we cannot show all the potential devices in this illustration, we use the glasses to denote them all. If these devices can perform the work of the gate at the same time, users can give away their smart phones.
- Like any technology, the metaverse needs an infrastructure to help with communication, processing, computation, rendering, simulation, storage, resource management and operating systems. This infrastructure is responsible for providing access to the interaction applications or technologies that make it easy to use the metaverse special technologies. What is more, the users will not need to have a powerful device to operate the application; all the user needs will be a good internet connection and good receptors, as all the other things will be managed by the cloud infrastructure. Furthermore, storage will be managed and secured as any application placed nowadays on the cloud with the same, or better secure storage standards, i.e, has a private space, uses user authentication and authorization to specify the provided content, can be shrunk or expanded as needed, and can be shared with other organizations, providers, or governors to facilitate works without violating users' privacy.
- The avatar of each user, which is a part of the mechanism of the metaverse, operates from the twin world to access everything in the metaverse and is responsible for receiving the real user requests and sending them back the metaverse response. As the avatar needs to ask for permission from the service provider of the metaverse to gain the ability to visualize the responses the user is waiting for, the avatar should operate the required software or files on the infrastructures they were uploaded to previously. When the avatar receives the user requests, it starts with making sure that the needed files are available and accessible. This includes sending the requests to the cloud that stores the virtual learning system, such as IAAS, PAAS, or SAAS.
- Metaverse special technologies are various and helpful to use all the aspects of the metaverse, and here, we describe in detail the need of each technique.
    1. Starting with the twin world, it is used to merge the virtual objects on scenes extracted by the camera, previously captured, or drawn as a 3D environment to be similar to the real world.
    2. A virtual world (VW) is an entire world built virtually to be compatible with the objects used in or created to be operated on the VW.
    3. The mirror world is a world that simulates everything in the real world with some noticed changes due to being mirrored.
    4. The service provider (SP) is the provider from which interaction applications should obtain permission to access the metaverse special technologies.
    5. Blockchain is the main aspect of the metaverse used to make continuous and serialized processes with unique identities to avoid fraud or losing data.

6. Augmentation is used to simulate the objects in 3D models using markers from the real world, mainly used in games and educational purposes.
7. Haptic is an application that provides kinesthetic communication to help provide a complete experience to the user.
8. The other supportive, cooperative, or independent apps have their existence and space in the metaverse special technologies too. All these technologies depend on two different technologies, i.e., financing and lifelogging. Lifelogging is used to record personal data, visiting logs, surfing history, etc.
9. Financing is usually used with applications that provide paid services.
10. We also have NFT and UGC. The non-fungible token (NFT) is usually a unique item or collection that has to be bought before being used, as they are already cryptographic items and cannot be replicated. Many NFTs are sold in auctions that increase or decrease their prices over time.
11. User-generated content (UGC) collects each user's content depending on the applications and their topics.
12. The sensation is also a very needed technology that is used to read from sensors and then send vibrations to user devices to provide them with the senses of the experience they are using.
13. We should also mention that there may be other essential technologies, but these are the important parts we can use for the moment to associate the new era of the virtual learning environment. Together, these technologies can provide the user with the best experience according to the course, the used materials, the version of technology they are using, the nature of the lectures or application content, etc.

As shown in Figure 2, the proposed virtual learning environment has adopted the metaverse framework to gain the advantage of this new technology and make the learning environment more interactive and intelligent. It considers the frameworks mentioned in [23,26–28]. It also merges Duan's framework of the metaverse [2], the Smart's roadmap described in [13], Boschert's digital twin [29], Heath's mobile education environment [30], and Sulaimani's interactive education system [31]. None of the researchers proposed or developed an environment that can work with all these technologies at once to the best of our knowledge. The main objective is to ensure that this E-Learning environment will run successfully on the metaverse and perform its functionalities in the best way, as it can use many of the metaverse special techniques at the same time. Here we can describe the way to implement the VLE in the metaverse:

- The device has an embedded interface to connect with the E-Learning environment of the metaverse. This device can be the phone as the start point, which may be changed with technology acceleration, to operate the app. The receptor devices, such as the 3D glasses and any other sensors, should be connected to offer the best user experience. The app interface is a part of an installable application on the user's device, a built-in application in the platform operating the user's device, or a link that operates only on a remote server, usually the cloud.
- As the infrastructure is mandatory, the physical connection is the main link between the user's devices and the metaverse. The main files of the virtual learning environment should be stored on a cloud to help in communication and computation processes on the infrastructure. Furthermore, the cloud will be responsible for providing the needed resources to the applications to operate systems, even if the user's devices are not compatible or will perform slowly. One of the best and most well-described infrastructures of E-Learning environments is [30]. In addition, users need to interact with each other (between students or the teacher), so [31] can be used to manage the interacting process. The need for the infrastructure in the metaverse-based applications was well explained by Lim et al. [28]. As Duan stated, blockchain is a core infrastructure of the metaverse. It is a part of the infrastructures of the applications uploaded

in the metaverse [2]. However, this is not all the servers' jobs only. Servers need to connect the digital twin to simulate, mirror, and visualize the augmented and virtual reality to gain the benefit from all the layers and capabilities of the metaverse. On the infrastructure, the files of the applications or systems, such as the files of Numina, InTeRaCt, VoRtex, educational games, or virtual campus ecosystem should be stored on the cloud servers to make it easy to use learning environments for both the real user and the avatar. Structure of the storage can be managed by the storage area network (SAN), data centers, or any other way to keep data safe. Data should be accessed by students, teachers, educational institutions, and the central educational offices, or ministries. We should emphasize that security practiced in the non-metaverse-based applications should be practiced on the metaverse too, i.e, authorized access, and users authentication.

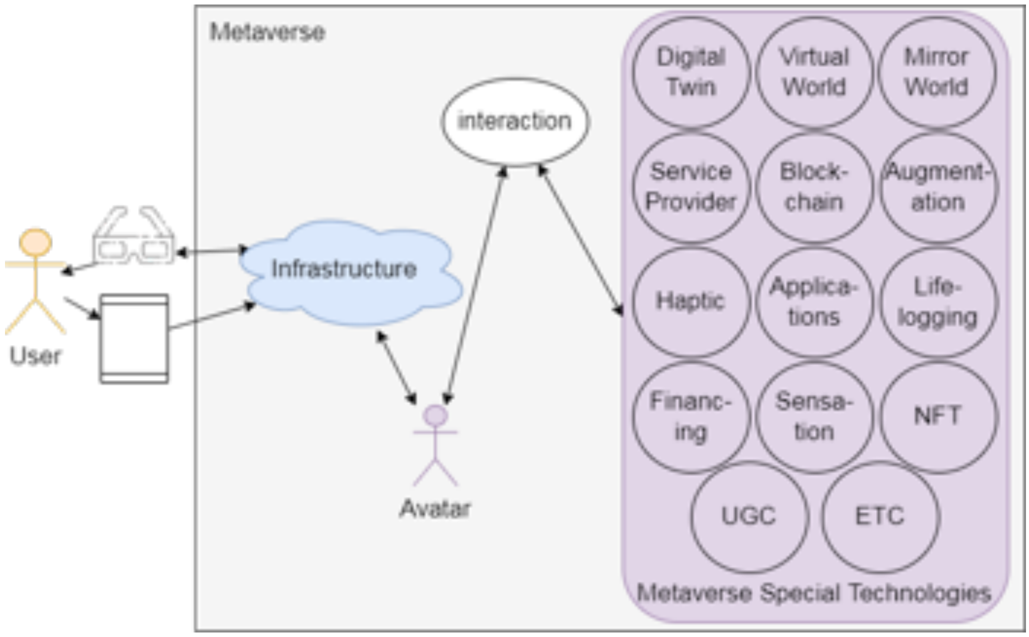

Figure 1. Metaverse framework.

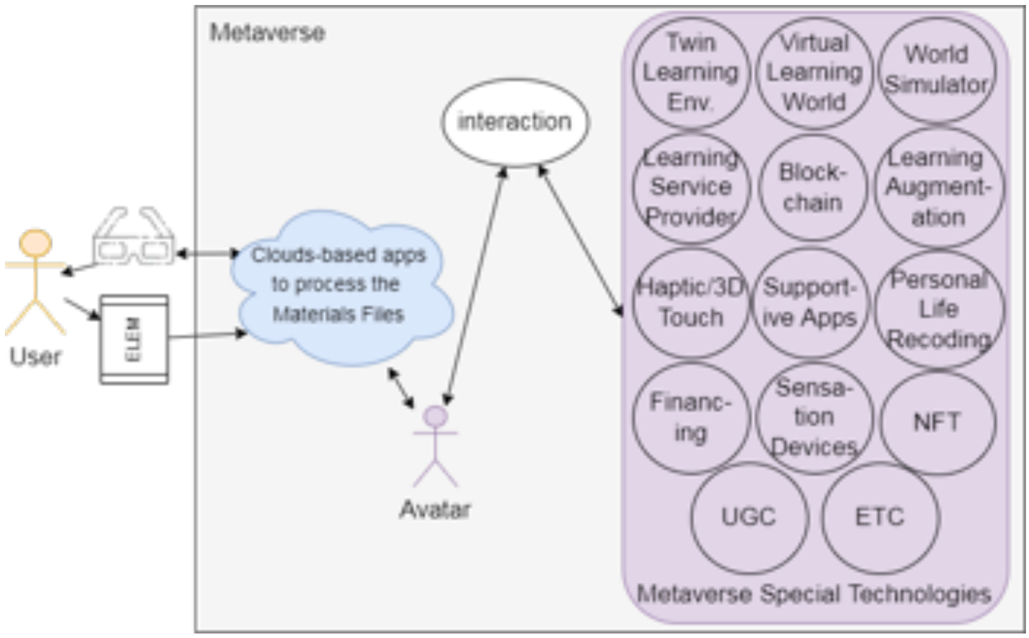

Figure 2. ELEM—framework.

- After that, the avatar needs to check the interaction applications, which is a combination of interfaces and cross-world ecosystems, according to Han et al. [26]. In this layer, the avatar needs to use the right interface of the right educational ecosystem before going forward to the metaverse special technologies, which should simulate the physical and real process and provide them in virtual reality modules.
- The avatar asks permission first from the virtual learning service provider to connect to the digital twin, which provides the response according to the sensations, virtual world, augmentation, blockchain, simulators, and the haptics. Whenever the user generates new content, both UGC and the lifelogging record, these changes are kept to be used in the future by data analysts. If the process needs payment for granting access, then the financing, NFT, and other supportive applications will be called.
- Digital twins need to link the virtual and physical worlds using the required infrastructure, supportive software, and avatars. The digital twin should call the virtual world processes corresponding to the request according to the user request. For instance, to explain the layers of the atmosphere, the digital twin needs to call the simulator, virtual reality, and visualizer to show the user the different objects and the corresponding information to each object regarding the level the user is enrolled in and the department the user is studying this course from.
- According to the roadmap, the virtual world consists of many sections [7]. These sections are connected and intervened. The virtual world is responsible for providing us with virtual results. As a core field for virtual reality, IoT is responsible for everything in the digital twin and explains the sensation results.
- Simulation is also needed to provide a show and the ability to study the inner layers of some physical thing, reactions of animals towards specific actions or organisms' tissues against chemical or allergy, and algorithm implementations. Simulation can provide us with a mirror of the physical world to reflect everything to the digital twin. Reality should be visualized using augmentation, virtual or extended reality software.
- Lifelogging allows the avatar to start a session in a new virtual application or be operated for the first time. After visualizing the response, the avatar should take it back to the user device to be shown.

We propose this framework to ensure the app is uploaded to the cloud, operated on the digital twin, visualized virtually for the avatar, and uses all the other technologies to gain the best advantages of employing such technologies.

4. Discussion

The metaverse has a framework that affects all the applications uploaded to the metaverse. This effect contains how the user deals with applications and how to manage these applications. Without knowing the framework of the metaverse clearly, the applications will be at the risk of being outdated, even if they were developed recently, because of using obsolete technologies. The apps that do not run on the metaverse will be abandoned shortly, as the metaverse is the future of the Internet. As a result, all the applications should adopt this new technology, and on top of it is E-Learning systems. Considering the framework of the metaverse proposed by Duan to implement CUHKSZ as a social campus application, ELEM recognizes the interaction part as a connection between the physical infrastructure and the metaverse special technologies. It ensures the simplicity of development, publishing, and maintenance. It also has the benefit of the metaverse framework. We can summarize the need of every special technique of the metaverse as follows:

- The user's avatar is responsible for operating everything in the metaverse instead of the actual user. The avatar should receive requests such as selecting a book or playing a video from the library of the E-Learning environment.
- The request should go to the physical infrastructure first to find the physical infrastructure of the E-Learning environment. Then, it should find its referred peer in the digital twin. Although the metaverse should be hardware independent, we should not forget the hardware considerations forced by such a framework, i.e., substantial

infrastructure resources and special devices for the user. In this way, we can ensure that both the metaverse and our virtual learning environment run smoothly and can adapt any changes in the future. When the educational management has uploaded the applications to the cloud, users can choose any applications in the physical environment. Numina, InTeRaCt, or any other application should have their virtual images in the virtual world and digital twin. Therefore, both data and processes can be visualized virtually for the avatars.

- The digital twin is one of the cores of the metaverse framework with the help of simulation, sensation, and the mirror world because it is the way to link both physical reality and virtual reality.
- This process will start the virtual world processes to send the virtual, for now, "3D", response using any combination of the virtual world processes and the haptics and augmentation.
- Simulation, sensing, and visualizing with augmentation or virtual reality are all part of the work of the virtual world from which the avatar needs to obtain responses before displaying them on the actual user device.

Finally, the metaverse itself is still not published commonly yet by any company, university, or researcher because it needs a computer with super-processing abilities and super resources to operate its features smoothly and provide it for all users with the same great abilities to solve both time and money issues; none of these are available at the time of writing this proposal. Moreover, many metaverse special technologies have still not been found yet, except for theories and research papers. Thus, to prove this framework of the E-Learning environment, we need to have the metaverse itself published and then implement the framework of the E-Learning environment on it. This means waiting for more years to have access to more modern technologies and apps to help operate the metaverse. We also did not go through the necessary supportive software, as they differ from one environment to another.

5. Challenges

The metaverse is considered the next-generation Internet paradigm that allows users to play, work, and communicate in the virtual world. With ubiquitous wireless connections and powerful edge computing technologies, VR users can immerse themselves in the virtual world by accessing VR services offered by different providers. In addition, we use metaverse-based applications to acquire safe and efficient environments for education and business. These systems implement virtual reality technologies and continuously study and endeavor to expand learning experiences [21]. However, VR applications cause intensive computation and communication, making it hard to access these systems via slow internet connections. In addition, simulation can cost both time and money too. As a consequence, users may never use VR-based applications [22].

Although the Internet is the main factor for continuous improvements, many countries are still totally or partially out of service. Consequently, students may not be able to access, interact with, or finish studying the materials within the specified time of the course. Furthermore, the educational process may fail when all the targeted students cannot or refuse to study online [32]. Suppose any country does not migrate its system to the metaverse; in that case, these countries will be outdated, and it will be hard for them to communicate or even finish any cooperative processes efficiently. Governments and companies have different applications that have started using the metaverse already, such as games and virtual currencies [4].

Developers, tailors, and architects are all supposed to unite their efforts to simulate everything related to the system we want to share on the Metaverse. They should focus on the presentation, interaction, and background functionalities [5], which depend on a massive effort. In addition, augmented reality is not ready to be merged with virtual classes yet because it is successful with only some types of learning activities that require a well-thought-out teacher touch [33].

A virtual learning environment provides us the ability to learn with creativity. It can easily explain the most complex problems while simulating processes and emotions. However, not all the courses and materials can be taught or visualized virtually on the metaverse. This includes religious courses, physical practices, and catastrophic dangers. This is not to contradict the truth of metaverse's amazing benefits, but because metaverse can teach, while practicing may be another story. Let us discuss this with some examples. When students need to learn about volcanoes or tornadoes, they can have a great experience with an interactive environment that they can see, feel and sense. However, they do not need to practice anything rather than safety precautions. On the other hand, in complicated surgery, students need to learn everything at once, which may not happen in regular cases. The main problem will be the practice because reality has great challenges and critical cases that cannot be undone, and lives cannot be retrieved. One more example is civil engineering practices. Lessons can cover many topics, problems, and issues, but practice is something else. In real lab and real projects, students can have experience with trial and error with real mistakes and real catastrophic effects. Metaverse applications can provide everything if the applications are provided with all the needed examples and scenarios, but practice in the real world cannot be replaced with anything because there are always some unknown variables that will reveal themselves during real practice. Morals or safety will always be an issue to be discussed and cannot be solved.

This type of technology depends on high computation processes, which affects the economy because cost increases with the advances in technology and the complexity of the embedded systems. When the cost becomes higher and higher, many students will not prefer to study using this technology. Their first choice will be self-study rather than paying so much to study.

6. Conclusions

Many technologies are emerging. Although these technologies may be sophisticated and not understood early, they can significantly change lives. E-learning applications are essential applications in our daily lives. Adopting new technologies in these applications is a necessity of our era. Metaverse is the most recent technology that is still not fully explored nor fully implemented yet. This research discusses the state of the art in order to provides a clear framework of the metaverse. The conducted framework is used to propose the virtual learning environment based on the metaverse. The metaverse framework is also used to ensure using all the capabilities of the metaverse at once. ELEM is proposed for easily running E-Learning applications on the metaverse. It merges many E-Learning and virtual learning environments with connecting the metaverse special technologies to accomplish the processes effectively. In the future, we recommend implementing ELEM to prove its effectiveness, provide all its functionalities accurately, and benefit humanity.

Author Contributions: Conceptualization, N.A.D. and A.A.-L.; methodology, N.A.D., A.A.-L. and M.A.A.; software, N.A.D.; validation, N.A.D. and A.A.-L. and M.A.A.; formal analysis, N.A.D. and A.A.-L.; investigation, N.A.D. and A.A.-L.; resources, N.A.D. and A.A.-L.; data curation, N.A.D.; writing—original draft preparation, N.A.D. and A.A.-L.; writing—review and editing, N.A.D., A.A.-L. and M.A.A.; visualization, N.A.D.; supervision, A.A.-L.; project administration, N.A.D. and A.A.-L.; funding acquisition, M.A.-R., M.S.A.-A. and T.A. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by King Saud University, Riyadh, Saudi Arabia, grant number RSP-2021/206.

Acknowledgments: This research was supported by the Researchers Supporting Project number (RSP-2021/206), King Saud University, Riyadh, Saudi Arabia.

Conflicts of Interest: The authors declare no conflict of interest.

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