Meta-Space: Pioneering Education in the Metaverse

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In the evolving landscape of learning methodologies, technology has emerged as a catalyst, transforming the educational experience. This study delves into the realm of Virtual Reality (VR) and Augmented Reality (AR), collectively referred to as the "Metaverse," as a pivotal tool in education. By conducting systematic literature reviews, we investigate the potential, effectiveness, and associated pros and cons of employing the Metaverse for learning. Our findings affirm that the Metaverse proves to be a highly effective learning platform, enhancing engagement through lifelike avatars and bridging the gap between the real and virtual worlds. While this innovative approach facilitates visualizing materials and fosters interactive and interesting learning environments, challenges such as the cost of requisite devices remain. Despite limitations, the advantages of integrating the Metaverse into education are evident, necessitating ongoing development to amplify benefits and address existing constraints. This research contributes valuable insights to the ongoing discourse on leveraging Metaverse technologies for enriching educational practices.

Keywords: Metaverse; Virtual Classroom; Education; Communication.

Introduction:

Learning is a lifelong journey, an ever-present thread woven into the fabric of our lives, guiding us to new insights and knowledge, regardless of age. From our earliest days, the pursuit of knowledge has been a fundamental aspect of our existence, often shaped by formal education. However, the methods through which we learn vary in their ability to captivate our interest. Traditional learning materials, dominated by text with sparse illustrations, often present a challenge to making the learning experience truly enjoyable and engaging.

In the contemporary landscape, the rapid evolution of technology has revolutionized various domains, with education standing prominently affected [1]. Technological tools, once as simple as projectors in classrooms [2], have now transformed into virtual classrooms conducted via video conferences, especially accentuated by the global impact of the COVID-19 pandemic. Yet, the shift to virtual learning comes with its own set of limitations, particularly in fostering interactive student-teacher and peer interactions.

Amid the ongoing quest for optimal technological solutions to enhance education, Virtual Reality (VR) and Augmented Reality (AR) have emerged as promising contenders [3][4]. Virtual Reality enables users to immerse themselves in computer-simulated environments, as seen in applications like Google Earth's VR implementation. On the other hand, Augmented Reality seamlessly integrates digital elements into the real world, exemplified by social media filters and popular games like Pokémon Go. Together, VR and AR converge to form what is colloquially known as the "Metaverse", a virtual realm that melds the tangible and digital universes.

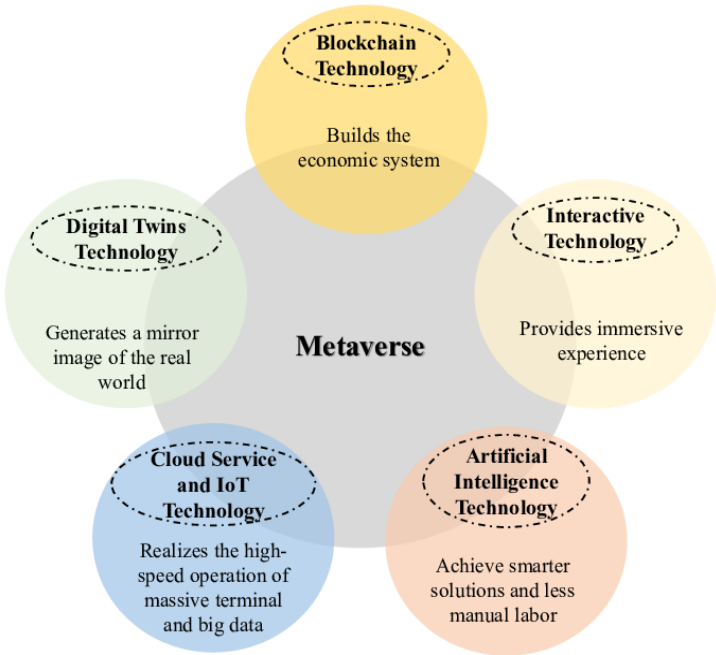

Figure 1: Metaverse-related technologies and their impact on the Meta verse [5]

In addition, the virtual classroom has broader applications in studying human behavior, skill training, and gaming. Neuropsychology benefits greatly from immersive virtual environments. The virtual classroom is revolutionizing education with its impact on accessibility, flexibility, and the learning experience. We examine the difficulties and opportunities for social good associated with the metaverse in this study as we delve into its complex domain. We look at how digital technologies might improve educational experiences and meet social requirements, especially in the setting of virtual classrooms. As part of our methodology, a

metaverse classroom is meticulously built using state-of-the-art technologies and techniques to guarantee realism and usefulness. Our study strives to unearth insights that pave the path for revolutionary improvements in education and beyond as we negotiate the complexity of the metaverse landscape.

Challenges in the Educational Metaverse:

Challenges from Regulators in the Education Metaverse:

The government and other regulatory bodies have not given the education metaverse the attention it deserves, which is one of its main challenges. Through resource sharing and real-time interactive platforms, this virtual learning environment offers enormous potential to educate more people. But because the regulators weren't involved from the beginning, there aren't any clear guidelines or directives. On paper, the government's plans don't offer enough support for this new approach to education, which incorporates socializing, trading, and creative activities in addition to traditional classroom instruction. Encouraging the regulators to join the education metaverse is essential to its growth and development [6].

Challenges Faced by Designers in the Education Metaverse:

The education metaverse is a dynamic and easily navigable digital learning environment that you can utilize at any time and from any location thanks in large part to the work of metaverse designers. Currently, the technology mostly depends on AR/VR/MR devices, however, there is a small issue. The learning experience isn't as immersive as we'd like it to be because of these devices' limitations. It's like having a great gadget that's not quite ready for prime time. The metaverse's required gadgets are also somewhat expensive and difficult to transport. So, even if you have this amazing learning space, it's not always practical to use it. Furthermore, designers still haven't quite figured out how to best organize the many components of the metaverse and determine what each one should be used for in terms of teaching. Therefore, more work needs to be done to ensure that the education metaverse is truly excellent.

Challenges Faced by Users in the Education Metaverse:

When users step into the education metaverse, they rely on a network of shared resources and strong social connections to enhance their learning. But here's the catch – the ethical rules of this virtual world haven't been set up properly yet. This means users might face similar problems as they would in the real world. Because the metaverse is a big collection of social ties, users might be tempted to explore using less trustworthy resources and tricks.

Metaverse for Social Good:

Even though the metaverse is essentially a virtual world centered around human interaction, it has a notable positive influence on the real world. This impact is particularly evident in areas such as accessibility, diversity, equality, and humanity. In the following section, we highlight some notable applications that showcase how the metaverse contributes to social good [7].

Metaverse Applications for Enhanced Accessibility:

In today's globalized world, communication and collaboration between countries have become more frequent. However, the challenge of geographical distance remains a significant obstacle, leading to increased costs in various processes. The COVID-19 pandemic further exacerbated this issue, causing the suspension of many events due to preventive measures.

Enter the metaverse, a solution that enhances accessibility to meet diverse social needs. For instance, numerous events have seamlessly transitioned to virtual formats, thanks to the metaverse. A notable example is UC Berkeley hosting its graduation ceremony on Minecraft in 2020. Additionally, platforms like Fortnite host a plethora of virtual events, including concerts such as the one featuring Travis Scott. These instances underscore how the metaverse has

seamlessly integrated into our daily lives, offering a cost-effective and secure means to fulfill our social needs.

Exploring Metaverse for Inclusive Experiences:

The limitations of the physical world, including factors like geography and language, make it challenging to integrate diverse elements in one place to cater to the needs of different individuals. Enter the metaverse, offering an expansive virtual realm with seamless scene transformations that can effectively achieve diversity. The metaverse provides a platform for a myriad of intriguing scenarios, breaking free from physical constraints. For instance, Animal Crossing organized a presidential campaign for Joe Biden, showcasing the diverse possibilities within the metaverse. Similarly, students at Stanford University exhibited their posters in Second Life. These examples, however, only scratch the surface as the metaverse hosts a plethora of activities spanning education, shopping, political campaigns, artwork, pets, haunted houses, and more. Consequently, the metaverse significantly fulfills the diversity requirements of our physical society.

Digital Twins:

Besides metaverse users, even things in our everyday world can also connect and interact with the virtual realm, appearing as digital twins in this digital space. Imagine them as identical virtual copies that mimic real-world objects. How does this work? Well, devices in the real world have their information collected through widespread sensing technologies. These technologies keep the virtual copies, or digital twins, updated to reflect the current status of their real counterparts. This connection between the physical and virtual worlds opens up exciting possibilities. It's like having a parallel version of the real world in the metaverse, allowing for a seamless exchange of information and actions between our physical surroundings and the virtual space.

Methodology:

This methodology presents a comprehensive guide to developing an interactive and immersive metaverse classroom using Blender, a powerful 3D modeling software. The process commences with meticulous planning of the classroom layout, encompassing crucial elements like avatars, furniture, walls, doors, windows, whiteboard, roof, and lighting. Designing the core structure in Blender involves creating walls, doors, windows, and roofs, ensuring accurate proportions and a realistic environment.

The methodology emphasizes applying appropriate texturing and lighting to achieve an authentic ambiance within the virtual classroom. Thorough testing and iterative refinement phases ensure optimal functionality and visual quality, promoting an immersive and rewarding learning experience. Upon successful completion, the virtual classroom project is saved in Blender and exported to incompatible formats, making it readily accessible and adaptable for various virtual reality platforms and Metaverse applications.

3D Modeling with Blender:

The very first step in our workflow, shown in Figure 2, is creating 3D assets for our metaverse. Before diving into Blender, we carefully planned the layout and design of the virtual classroom. Considering the essential elements, such as avatars, chairs, tables, walls, whiteboards, windows, doors, roofs, and lighting. We envisioned a modern and interactive learning space to ensure an engaging and immersive experience for students.

Designing Classroom:

With the design plan in mind, we opened Blender, the powerful 3D modeling software, created a new project, and set the appropriate dimensions for the virtual classroom scene. Using Blender's versatile tools, creating the core structure of the virtual classroom. Modeling the walls,

doors, windows, and roof to give the classroom its basic form. We ensured that the proportions and scale were accurate to provide a realistic environment.

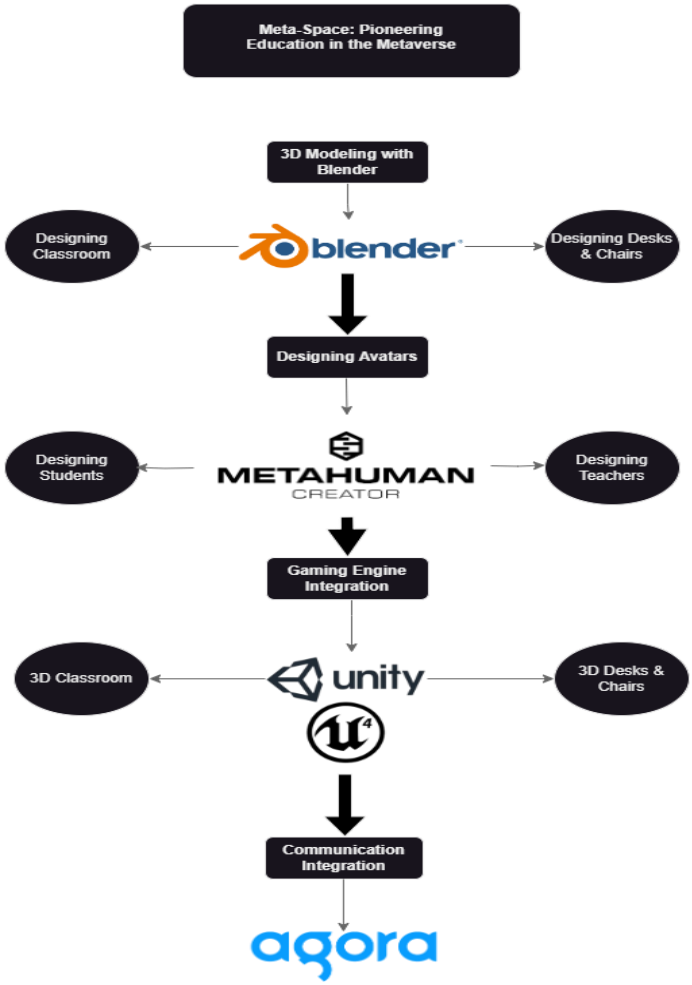

Figure 2: Meta-Space Flowchart.

Designing Desks and Chairs:

We focused on designing the furniture and props for the virtual classroom. Using Blender's modeling tools, we crafted chairs, tables, and a whiteboard that fit seamlessly into the classroom setting. Attention to detail, such as textures and colors, to make the objects visually appealing and true to real-life counterparts.

Designing Avatars:

Meta-Human Creator is a free, cloud-streamed tool you can use to create your digital humans in an intuitive, easy-to-learn environment. Using Meta Human Creator, you can customize your digital avatar's hairstyle, facial features, height, body proportions, and more [8]. In the Metaverse classroom, integrating avatars using Meta Humans enhances interactivity and engagement. These lifelike digital representations of users allow for real-time communication and collaboration. Avatars foster active participation in discussions, role-playing, and group activities, creating a personalized and immersive learning environment. With that in mind, we created avatars for teachers and students.

Gaming Engine Integration:

A gaming engine like Unity or Unreal Engine would be the perfect platform to use to bring our Meta-Space concept to life, merging our 3D classroom elements like chairs, desks, and avatars into a unified virtual setting. Using a gaming engine's capabilities enables dynamic

interactions, smooth asset integration, and the deployment of several functionalities. We can give avatars the ability to move around the virtual classroom, interact with furniture like desks and chairs, and even participate in group activities by using scripting and programming within the gaming engine. These engines also provide capabilities for improving visual fidelity and performance, guaranteeing an engaging and immersive experience in our Meta-Space environment.

Communication Integration:

Agora SDK is an all-inclusive real-time communication solution that gives developers the infrastructure and resources they need to incorporate message, audio, video, and live streaming features into their projects. The Agora SDK's capability to provide 3D spatial audio is one of its most notable features. By mimicking how sound behaves in the real world, spatial audio improves the immersive experience of virtual worlds by enabling users to detect audio sources from various angles and distances. Agora uses spatial audio techniques and sophisticated audio algorithms in its SDK to do this. Agora SDK generates realistic audio environments that improve users' sense of presence and immersion when interacting with 3D spaces or virtual worlds. These environments are achieved by precisely placing audio sources within a virtual space and adjusting properties like volume, directionality, and distance attenuation. Applications where spatial awareness and realistic audio interactions are crucial for an engaging user experience, like virtual events, online gaming, remote collaboration, and virtual classrooms, will greatly benefit from these capabilities. We currently are working to implement Agora SDK in our project.

Results:

The results of the experimental process yielded insightful findings across various dimensions, shedding light on the efficacy and potential of the implemented metaverse classroom.

Classroom in Blender:

The classroom is designed with a capacity of 10-15 students. This number ensures that there isn't too much traffic on the server. The classroom has enough room for the teacher to move around during lectures and for students to not get too cramped in a space.

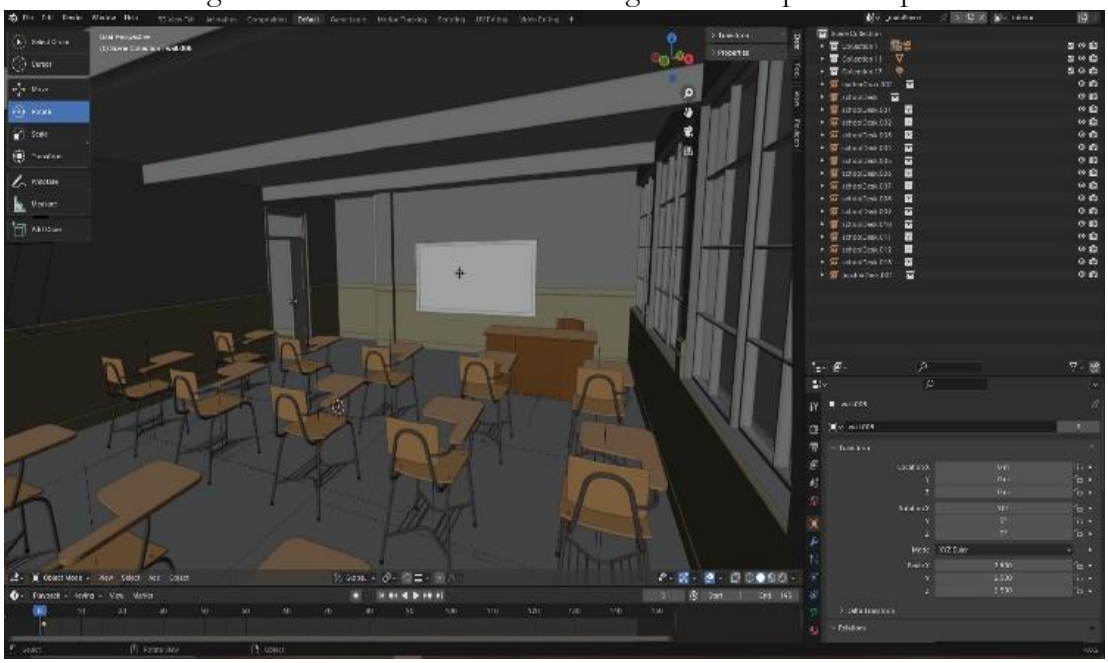

Figure 3: Classroom Model in Blender.

Furniture and Props:

For the furniture, we designed simple chairs and desks for the classroom to give a real-life-like feeling. The props include lights in your classroom and a whiteboard. The users can freely interact with the furniture and lights, bringing the virtual classroom to life. Figure 3 and Figure 4 show the whole classroom and the teacher's desk.

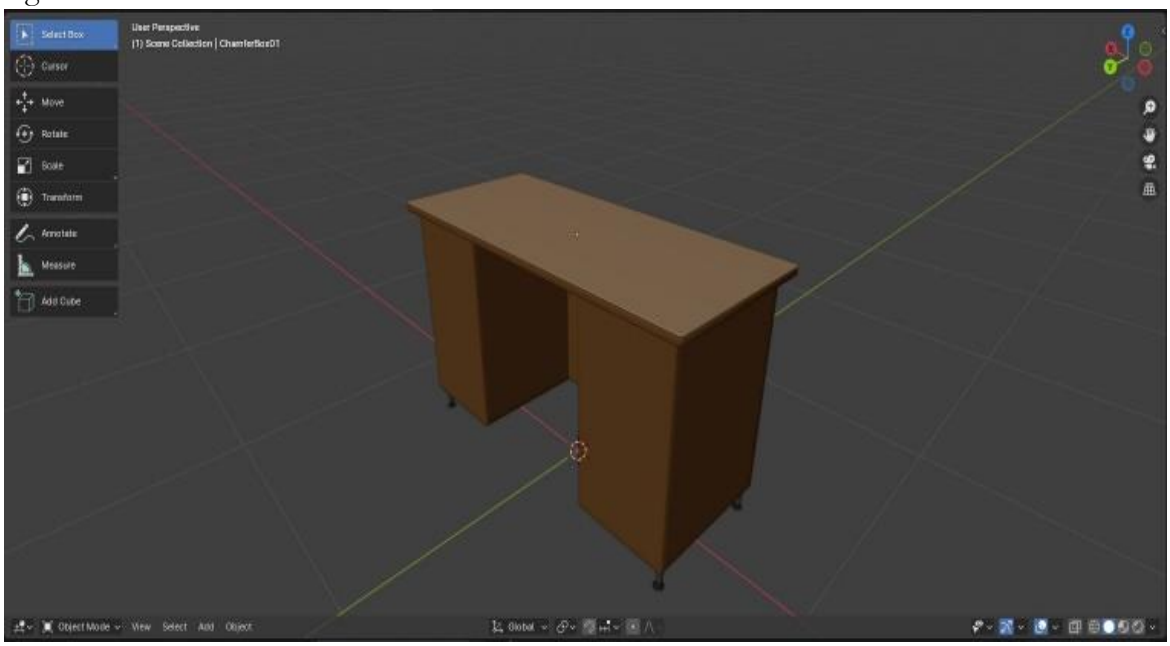

Figure 4: Modeling of Desk in Blender

Avatars for the Classroom:

In the Metaverse classroom, we are currently working on integrating avatars using Meta Hu men, which enhances interactivity and engagement. These lifelike digital representations of users allow for real-time communication and collaboration. Avatars foster active participation in discussions, role-playing, and group activities, creating a personalized and immersive learning environment. In Figure 4, we tried to create our professor digitally.

Figure 5: Sir Yasir Avatar in Meta-Human

Conclusion:

To sum up, the education metaverse has the amazing potential to completely transform the way we learn by removing obstacles based on geography and enabling access to education for everyone. We do, however, have certain obstacles. To control the expansion of the metaverse, regulators including the government, need to be more vigilant and establish explicit guidelines. To use accessible technology to create an immersive and useful learning experience, Designers have their work cut out, too, as they strive to make the learning experience immersive and practical with accessible technology. While social networks and shared resources are beneficial, users must exercise caution to avoid taking unnecessary risks in this rapidly changing digital environment. To guarantee that everyone involved has a positive and meaningful learning experience, teamwork, careful rules, and ongoing technological advancements are necessary to realize the full potential of the education metaverse.

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