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Revolutionizing Medical Education with Metaverse

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ABSTRACT

Metaverse in Healthcare/Medical education has the potential to be an interactive, immersive, and recreational experience tailored to every individual. It can provide new opportunities for healthcare providers to interact with patients in ways that are more intimate. It could for example as walking through a three-dimensional model of the human body with patients, discussing diagnoses and treatments. This would allow providers to simulate the effect of a proposed treatment on the patient's body before it is applied, creating a more personal and informative experience compared to what is currently possible with two-dimensional images on a screen. This paper focuses on the methods that could be leveraged for revolutionizing the medical education and training using metaverse.

Keywords: Metaverse, Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR)

I. INTRODUCTION

The learning through personal computers (PC), have come long way. eLearning in the late 1990s boomed because of the internet. The second wave of mobile computing and social media ushered in Microlearning through shorter, video-based learning on demand could be said as the next wave through social media and mobile computing. Industry watchers are now suggesting that the future era of computing is upon us. Flat static pages on the PC and phone will be replaced by a metaverse of digital 3D spaces, where people will interact as lifelike avatars. The metaverse is an embodied internet. The prefix "meta," which refers to the virtual world, plus the suffix "verse," which refers to the physical world, makes up the term metaverse.

Unlike a Zoom call that is scheduled and disappears when done, the metaverse is "always on" and affords social interactions with peers. This transition has profound implications for capacity building and learning [1].

The metaverse is upon us. Soon it will be as omnipresent as Facebook (now Meta) Instagram and TikTok.. Meta builds technologies that help people connect, find communities and grow businesses [2]. As technology advances to bring us new immersive and imaginary worlds, how to educate students and prepare teachers must also advance to meet these new opportunities. When education lags the digital leaps, the technology defines what counts as educational opportunity rather than educators. This is largely what happened with the introduction of "educational" apps designed to be used on smartphones and tablets meant for adults.

Today, as the metaverse infrastructure is still under construction, researchers, educators, policymakers, and digital designers have a chance to lead the way rather than getting caught in the stream. To leverage the potential of the metaverse as a 3D, global, interconnected, immersive, and real-time online space, new ways to connect the physical world with augmented and virtual reality (VR) experiences is the need of the hour.

Web 3.0 and the metaverse [3] are expected to have a massive impact on reassessing how we live our lives, just as web 2.0 and the internet did when they first burst onto the scene. Through Augmented Reality (AR), Virtual Reality (VR), and other related technology, the metaverse can bridge the gap between the physical realm and the virtual world and as such, its applications could be endless.

II. ROLE OF METAVERSE IN EDUCATION

One of the many use cases of the metaverse could be its role in the future of education. The remote capabilities of the technology, coupled with the endless virtual possibilities, can transform schooling as far as we know it.

Experts believe that, as long as the metaverse can conform to the best principles for learning, it could transform how lessons are taught and how students learn. These best principles can be broken down into six basic criteria (6C's), according Brookings Institute research [4].

2.1. Collaboration: Social interactions are central to human behaviour. They also foster a spirit of learning, cultural understanding and community building. Such associations help instil the quality of self-regulation during engagements, which is something that elementary schools strive to achieve in children's formative years.

2.2. Communication: Speaking, reading, writing and listening together comprise communication. Earlier, these were developed through in-person interactions and physical mentoring. However, replicating it in the metaverse is a challenge.

Thanks to advanced technology such as AR, VR and more, collaborating and communicating with one another in the virtual world is child's play.

2.3. Content: Conventional methods of learning have always involved paper content that cannot be frequently tailored for customised learning experiences. In the metaverse, a combination of collaboration and communication will play a crucial role in determining what content shall have to beoffered in the virtual world to best facilitate learning.

2.4. Critical Thinking: Students commonly struggle with this vital skill, as they are too young at the time to know what they can do with the information in hand. Applying the knowledge in other areas of life by self-evaluating the pros and cons of doing so involves some guidance. If the children are to be able to reason, they should first learn to collaborate and communicate amongst themselves in order to be able to listen to alternate viewpoints, present their own, and make an informed decision.

2.5. Creative Innovation: Amalgamating the offered content with critical thinking leads to creative innovation among children. Here is where gamification of content helps as it not only provides audio-visual aids but also lets students visualise what they're learning. Play-based learning also ignites curiosity, even if dormant, thus encouraging further exploration of the subject matter. Interestingly, according to the World Economic Forum, creativity is also the 3rd most sought after skill for employment.

2.6. Confidence: This trait plays a crucial role in making learners flexible as well as persistent. Usually, over-fixation on performance leads to dwindling confidence and may end up compromising interest in learning. If the learner is able to use the above 5Cs comfortably, the sixth comes naturally.

As can be seen, the six 'Cs' are often interdependent and inculcating these characteristics into a virtual teaching model does present a challenge. However, tech has always found a way to overcome obstacles and the hope is that it can do the same in the realm of education.

As the virtual world focuses on delivering an immersive experience through cutting edge technology, developers must focus on the end objective – learning through the experience.

It is imperative to get the social interaction component right from the start," says the Brookings report. Interacting through avatars may not be appealing at the start, and despite having them dressed in the most fashionable clothing online, they may not be the perfect replacement for physical interactions. The biggest challenge of them all shall be the fusion of both worlds in a manner that preserves "real teacher-child, caregiver-child, and child-child social relationships.

Moreover, learning games and other metaverse experiences will have to be more diverse and be culturally inclusive for all. Developers will also have to be mindful of the fact that misinformation is widespread on the internet, and the flow of any such misdirected propaganda does not enter the metaverse.

III. REVOLUTIONIZING MEDICAL EDUCATION THROUGH METAVERSE

According to health professionals, the Covid-19 pandemic age might benefit from the use of the metaverse, a combination of virtual and real-world space. An expansion of the metaverse's experience is needed so that its users can realize the need for medical education. It is a more sophisticated kind of virtual reality than what is already available (VR). Extended reality (XR), which includes virtual reality (VR), augmented reality (AR), and mixed reality (MR), is the metaverse's primary technology (MR). At a symposium conducted recently, medical specialists debated the virtues of the metaverse and its limits in medicine, and the role it plays in medical education [5].

3.1 Generating interaction with medical students

The most significant benefit of the metaverse is that it allows people to engage with one another while pursuing online practical medical courses, unlike the current one-way schooling. Healthcare will utilize it in medical education for simulation training rather than knowledge dissemination. For example, advanced skills and interactions need extra technology in the metaverse-based medical training, in order to be successful.

Surgery, for example, requires not just an understanding of the metaverse but also the use of instruments that need dexterous grasping abilities. This necessitates the use of appropriate hardware or tracking technologies. Metaverse technology has to be more flexible and adaptable on an individual basis.

Since metaverse programs are still in the experimental stage, it will be difficult to validate them and determine if a system regularly generates outcomes that satisfy the predetermined criteria. Instead of restricting access to the metaverse, it should be expanded.

3.2 Virtual Reality in Medical Education

Metaverse is the augmented virtual world which is derived by the convergence of virtual and physical space, where users can interact within the augmented world, to meet each other virtually and can immerse themselves in performing virtual activities that gives real experiences [6].

While Metaverse is evolving, it holds new potential in healthcare that combines the technologies like Artificial Intelligence, Virtual Reality, Augmented Reality, Internet of Medical Devices, Web 3.0, intelligent cloud, edge and quantum computing along with robotics to provide new directions to healthcare [7].

Virtual reality is getting used by doctors and experts to train fellow doctors and medical staffs, wherein

virtual reality can be leveraged to take a learner within a human body and can provide 3600 view of patient's ailment or to replicate procedures that are applied in real world.

A growing number of physicians and professionals are using virtual reality to teach other doctors and medical staff. Virtual reality may be leveraged to imitate operations applied in the real world. IoT, DLT, 6G or even 10G networks, robots, bring-your-own-computer interfaces, AI, cloud, edge, and quantum computing will all be included in the development of VR, AR, and MR systems that will be used in medical diagnosis, treatment, and prevention[8].

Surgical Operations using Augmented Reality

As medical operations previously used, augmented reality is now being used in more complex surgeries. Whether removing dangerous tumors or conducting a complex spinal Surgery, surgeons always look for better methods to get the job done[9]. While robot-aided operations were already in use to undertake complex procedures with accuracy and flexibility, the employment of robotics was a relatively recent development.

As surgical procedures were already using robotics, now complicated surgeries are all set to use augmented realities. Be it removal of cancerous tumors or performing a complicated spinal surgery, doctors are looking forward to new ways of performing these surgeries with precision. Usage of robotics or what is also known as robot assisted surgeries were already in use to perform complicated procedures with precision and flexibility.

3.3 Bridge-building between nursing school and real-life patient care

It is the responsibility of instructors to provide high-quality information that they may use in virtual programs to simulate on-site nursing abilities. Teaching students when their jobs have been terminated has been difficult for nursing schools. Learners should feel as though 'there was no difference in clinical treatment after performing this in the metaverse setting [10] in a clinical field experience program. It is a massive addition to healthcare and is set to make patient care better, especially in the long run.

3.4 Interoperability is a fundamental part

As we know, the next wave in healthcare is all about enhancing solutions, which are interoperable and open. The metaverse has several different asset types: avatars, 3D models, mixed reality, and spatial settings all work together to generate content packages. Data and communication standards will grow with the industry, facilitating cross-metaverse collaboration. With interoperability and openness being at the forefront of healthcare's next wave of innovation, the metaverse is not complete until the assets and data that make up these metaverses are simple to transfer across platforms and networks [11].

3.5 Virtual Reality and Augmented Reality

Virtual reality and augmented reality are already making a difference in patients' lives. In even the most basic operations, such as intravenous injections and blood draws, new technology like Accuvein's skin-projected vein map may improve outcomes [12].

Optimus Mixed Reality, which uses the Microsoft HoloLens [13] to blend the real and virtual worlds, was recently unveiled by Zimmer Biomet [14] and Medtronic [15]. As these vast MedTech businesses and a rising number of startups creating AR and VR solutions demonstrate, the surgical environment will likely undergo significant change soon[16].

It is also worth noting Veyond Metaverse[17], which brings together healthcare specialists from all around the world to collaborate on medical operations. Cloud-based and real-time communication technologies allow professionals to practice their skills with the highest accuracy to guarantee that everyone gets the most satisfactory healthcare service at any time and in any location.

It's too early to tell whether this will lead to healthcare being a part of the metaverse. But anybody who has utilized a digital avatar at a virtual meeting or event has already gotten a taste of what the future may contain. And we are already witnessing the development of healthcare-specific metaverse systems.

The metaverse has immense promise for healthcare innovation and improvement in its infancy. Watching the implementation evolve will be intriguing. Having a place where people can face reality without necessarily experiencing the reality is pretty fascinating. It is probably one of the reasons why metaverse has been identified as one of the best innovations in the healthcare industry over the last couple of years.

While metaverse is pretty promising, it is still a new field and has its shortcomings. Its complications will only require new solutions over the next couple of years.

3.6 Building Metaverse Apps

With companies like Microsoft supporting different tech stacks to build metaverse apps rapidly, this space is definitely going to get crowded. Some of the tech stacks provided by Microsoft on Azure around Metaverse [18]

- Microsoft Mesh mesh and HoloLens
- Microsoft Power Platform https://powerplatform.microsoft.com/en-us/
- Azure AI and Autonomous Systems
- Azure Synapse Analytics
- Azure Maps
- Azure Digital Twins
- On the other side, AWS [19] provides various solutions and services to enable Game Tech:
- Amazon GameLift for dedicated server hosting and
- FleetIQ to support multiplayer games.
- Amazon Lumberyard game engine.

IV. CHANNELS FUELLING USE OF METAVERSE IN HEALTHCARE

Three major channels are fuelling the use of metaverse in healthcare industry. During the COVID-19 pandemic, the use of telemedicine gained a lot of traction, as before that only 43% of healthcare facilities could deliver remote therapy to patients. That percentage has now risen to 95%. Metaverse will supplement telemedicine visits with a virtual office, where patients and physicians can meet in a 3D clinic or any other location. Only 43% of healthcare facilities could deliver remote therapy to patients. That percentage has now risen to 95%. Metaverse will supplement telemedicine visits with a virtual office, where patients and physicians can meet in a 3D clinic or any other location [20].

4.1 Tele-Consultation

Tele-consultation services have also gained a lot of attraction owing to the Covid Pandemic and are projected to improve the user experience significantly. Next-level immersive technology using VR, the metaverse in healthcare enable by providing a considerably higher sense of "being there" than other virtual environments like websites, messaging applications, or social media.

Therapy is another area where the metaverse in healthcare can be highly effective. Patients can interact with situations that cause them anxiety in safe environments where every aspect of the interaction can be closely monitored and controlled. For instance, gameChange[21], a virtual reality system developed by Dr. Daniel Freeman and his colleagues at the University of Oxford is using VR to treat psychosis using a form of medical technology known as digital therapeutics or DTx.

4.2 Blockchain

Blockchain is a critical part of the metaverse in healthcare, according to experts, because it allows for decentralized communities controlled democratically

via smart contracts, as well as a record of digital "ownership" of environments or even items in the digital world. The management and security of our highly valuable health data is blockchain's most prominent use case in healthcare.

4.3 Digital twins

A digital twin is a virtual model or simulation of any object, process, or system that is created using real-world data to learn more about its real-world counterpart. In the metaverse, the patient's digital twin could be the patient themself. The following figure illustrates the steps involved in application of digital twins in health care ecosystem.

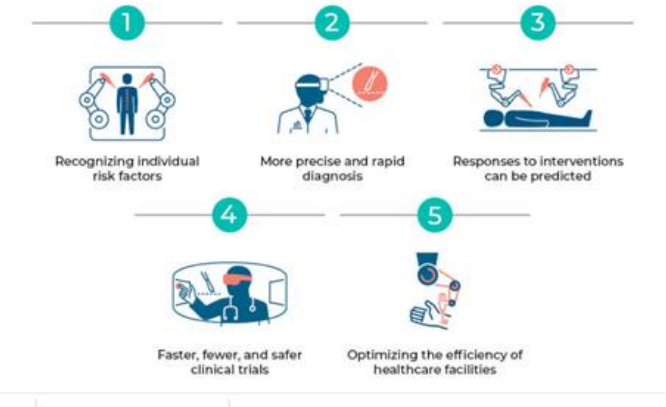

Fig 1: Application of Digital twin in Health Care (Source: https://www.netscribes.com/)

V. CONCLUSION

To conclude Metaverse is an emerging concept that will bring many new dimensions as the big social players bring different aspects of virtual reality and immersive experiences together, for healthcare segment which has largely remain traditional, it will be a great tool to learn, empower and provide blissful experiences to patients and providers. Meta builds technologies that help people connect, find communities and grow businesses.

Metaverse is going to revolutionize the medical education, surgical training, and patient treatments to save patients' lives and improve the standard of care by enhancing medical procedures, diagnosis, treatment, and expand worldwide access through proprietary cloud platform. Certain metaverse platform provide customized, high quality medical training to audiences remotely to large urban settings or remote locations with nano-precision. Communication infrastructure is optimized for the global cloud and communication network. This highly advanced communication ecosystem allows global interaction in real-time and makes it possible to perform medical procedures with the highest precision. Using AI, machine learning, and augmented reality, clinicians can access the most advanced communication tools available. Using AI, machine learning, and augmented reality, clinicians can access the most advanced AR, VR, haptic, and AI technology and solutions. Healthcare professionals can immerse themselves in the transformational metaverse hospital; thus, opening boundless possibilities.

The future use of metaverse **in healthcare things is that it is going to make things easier for patients by facilitating collaboration among healthcare professionals. This** would allow for quicker identification of the underlying causes of illness. Monitoring patient activity in the metaverse also allows for easier tracking of variables like compliance, which will aid in the diagnosis and treatment of illnesses.

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