TLIC PAPER

Fostering Diversity and Inclusion in Medicine: Collaborating with Extended Reality and Medical Simulation in the Metaverse

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ABSTRACT

Metaverse is a term used to describe a hypothetical shared virtual space where people can interact with a computer-generated environment and each other, and there are multiple metaverses currently being developed by various companies and organizations. Cooperation in the metaverse is at the core of the ongoing digital revolution that impacts the way we design and deliver overall education and training. Medical simulation is a powerful way to deliver education and training, based on the use of technology and other techniques to recreate clinical scenarios for the purpose of teaching and training healthcare professionals and students. This article is about how to involve learners in a metaverse within the medical simulation field. The key questions that we address are as follows: What is the metaverse today? What will it look like in a few years? How do we enhance medical simulation based on cooperation in the metaverse? How do we engage learners with diversity and inclusion?

KEYWORDS

extended reality, metaverse, cooperation, diversity & inclusion

1 EXTENDED REALITY AND METAVERSE FOR EDUCATION AND TRAINING

Extended Reality (XR) is an umbrella term used to describe a combination of virtual reality, augmented reality, and mixed reality technologies [1]. XR provides users with immersive experiences that can be used for various purposes, including entertainment, education, and communication [2]. With the growing use of XR, there is an opportunity to leverage this technology to promote cooperation as well as diversity and inclusion.

This paper explores the potential of XR to promote cooperation and boost diversity and inclusion in the metaverse based on the experiences developed

using e-REAL® that is the enhanced reality system for immersive simulation that we have been developing at Logosnet since 2012. Primarily, e-REAL is the merging of real and virtual worlds, a mixed-reality environment for hybrid simulation where physical and digital objects are available for gesture shaping, visual, tactile, and vocal interaction both in a physical learning setting and online. The e-REAL immersive setting is fully interactive with 3D visualizations, avatars, electronically writable surfaces, and more. It is a glasses-free solution, where users experience full immersion without the need for Virtual Reality (VR) glasses or goggles [3].
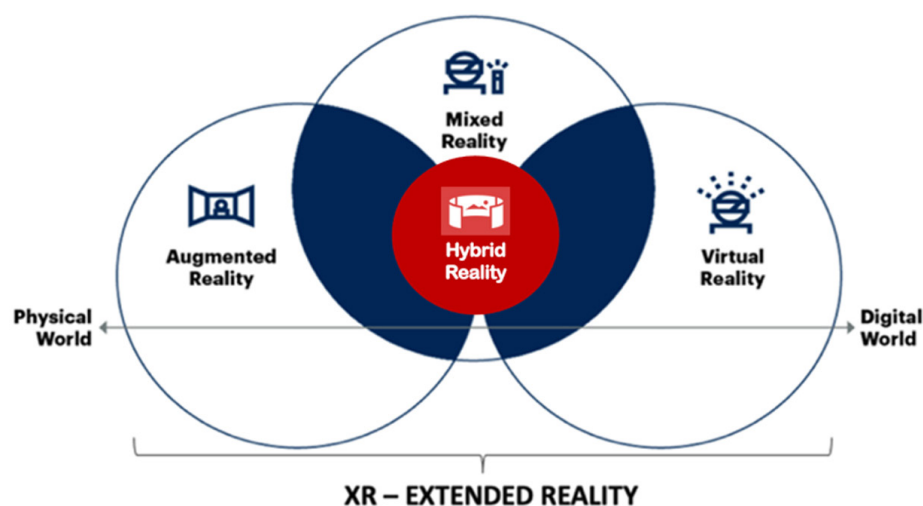

Fig. 1. The immersive spectrum of XR with e-REAL at the core (red dot) as a hybrid reality solution enabling glasses-free learning experiences, both on site (Mixed Reality into a "phygital" environment or Hybrid Reality) and online (cloud-based Virtual Reality)

Metaverse is a term used to describe a hypothetical shared virtual space where people can interact with a computer-generated environment and each other, and there are multiple metaverses currently being developed by various companies and organizations. The metaverse is expected to be a virtual space where users can interact with each other in real time. Even if there are companies and organizations stating that the metaverse is already there, we assume that the metaverse is something under development—there will be more than the virtual place already available. A fully developed metaverse doesn't really exist today. It is expected to be a collective virtual space, created by the convergence of virtually enhanced physical and digital reality, like the virtual objects and the avatars that we are interacting with inside the e-REAL labs.

With the avatars to speak with and interact with, as well as the interactive digital objects and the multisensory 3D scenarios, we are currently working with some of the key components of a metaverse. And, let's say, we are "e-really" expected to develop a metaverse in less than 5 years from now [4]. Let's think of it as the next version of the Internet: We're a few years away from the actualization of the Internet's 3D layer of interoperable and interlinked immersive environments needed to have a metaverse. Media headlines bolster any extended reality experience as the metaverse, but it is misleading because today we only have some of its infrastructure components. The full metaverse will be used for various purposes, including gaming, socializing, and learning because the metaverse has the potential to provide a safe and inclusive space where users can engage with others regardless of their physical location, race, or gender [5], [6].
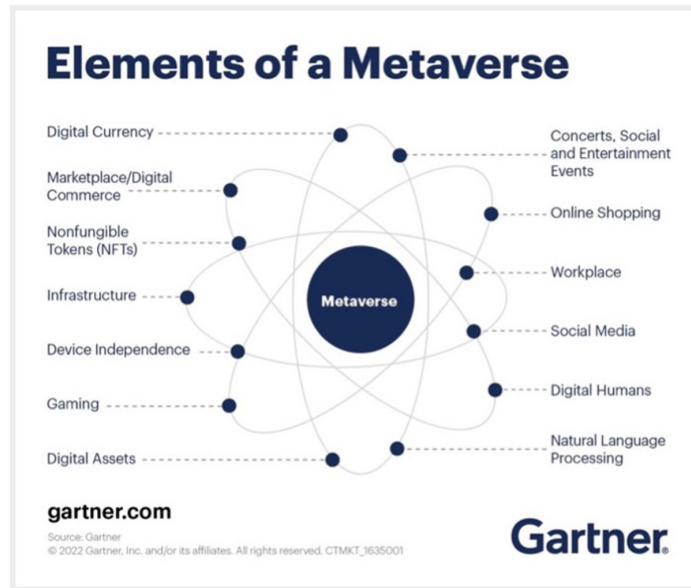
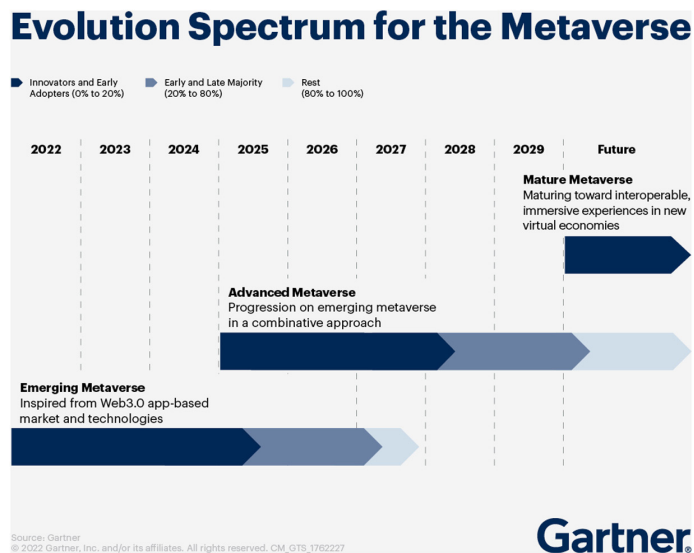**Fig. 2.** The elements of a metaverse according to Gartner Group

Fig. 3. The evolution spectrum for the metaverse according to Gartner Group

2 DESIGNING AN IMMERSIVE LEARNING EXPERIENCE IN THE METAVERSE

Today we can already deploy our training and simulation programs in a metaverse-like environment such as e-REAL. We are doing so in order to explore and envisage what the metaverse looks like in terms of instructional design. Designing an immersive learning experience—like a medical simulation—in the metaverse requires a multi-disciplinary approach, incorporating aspects of education, game design, and virtual world development [7], [8], [9]. Moreover, the most effective and meaningful XR seems to be possible only when different expertise domains are represented in data and content (e.g. ophthalmology

and neurology). Here are some general steps that can be taken to create such an experience:

- Identify the learning objectives you want to achieve through the immersive experience.
- Determine the target audience for the immersive experience, including their interests, preferences, and learning styles.
- Choose a platform enabling a metaverse experience: it will be a platform enabling presence and shared experiences from anywhere—on any device—through mixed reality applications. e-REAL is an effective solution because it enables the merging of real and virtual dimensions.
- Build a virtual environment that is immersive and engaging: This should include interactive objects, 3D models, audio, and other elements that create a realistic experience. Consider which elements will best support your learning objectives. Will it be a virtual trip, a game, a simulation, or something else? The elements you choose should be able to create a sense of presence and immersion for the learners.
- Create a story or scenario that the learners can become fully engaged in. This can be done through storytelling, role-playing, or—as in our case—simulation that is inclusive also of role-playing.
- Incorporate learning materials into the virtual environment, such as videos, audio recordings, text, and interactive activities. This should be done in a way that is fun and engaging but also facilitates learning.
- Provide interactive elements like quizzes, challenges, and games can help keep learners engaged and motivated. Interactive elements can also be used to reinforce key learning points.
- Design scenarios and challenges that require the learner to use critical thinking, problem-solving, and decision-making skills to progress through the experience. These should be designed to align with the learning objectives and to provide feedback to the learners.
- Use technology to enhance the experience: Technology can be used to create a more immersive learning experience. For example, virtual reality can be used to create a fully immersive environment, while augmented reality can be used to enhance the learner's understanding of a concept.
- Provide feedback to the learner throughout the experience, including progress updates, achievements, and challenges. This helps to keep the learners engaged and motivated. Feedback and assessment are crucial elements of any learning experience. They help learners understand what they have learned and where they need to improve. Incorporate these elements into your immersive learning experience to make it more effective.
- Finally, it's important to continuously evaluate and improve your immersive learning experience. Gather feedback from learners and adjust as needed to ensure that your learning objectives are being met.
- Test the immersive experience with a small group of learners and gather feedback to refine and improve the experience. This process should be iterative, with feedback incorporated into the design to create a more effective and engaging experience.

By following these steps, we can create an immersive learning experience that engages learners and helps them develop new skills and knowledge. e-REAL, as a Mixed Reality environment for hybrid simulation, can be a stand-alone solution or even networked between multiple locations, linked by a special videoconferencing system optimized to process operations without perceivable latency. This connectivity

allows not only virtual object sharing (like medical imagery, infographics, etc.) in real time, but also remote cooperation between participants.

3 INTERPROFESSIONAL COOPERATION AND MEDICAL SIMULATION IN THE METAVERSE

Interprofessional cooperation in medical simulation refers to the use of simulation-based education to train healthcare professionals from different disciplines to work collaboratively as a team. The metaverse will be a collective virtual shared space created by the convergence of virtual reality, augmented reality, and other immersive technologies. Combining these two concepts can potentially provide a unique and effective way to train healthcare professionals in an immersive and collaborative environment.

One possible application of interprofessional medical simulation cooperation in the metaverse is to create a virtual hospital setting where healthcare professionals from various disciplines can interact and learn to work together to provide patient care. The virtual hospital can be designed to simulate different clinical scenarios, including emergency situations, surgeries, and patient consultations. Healthcare professionals can use virtual tools and equipment to perform various procedures and communicate with each other to make decisions and coordinate care.

The use of the metaverse in interprofessional medical simulation cooperation can offer several advantages. Firstly, it provides a safe and controlled environment for healthcare professionals to practice and learn new skills without putting patients at risk. Secondly, it can help break down communication barriers between healthcare professionals from different disciplines by providing a common virtual space for them in which to interact and collaborate. Lastly, it can enhance the learning experience by providing immersive and engaging simulations that can better prepare healthcare professionals for real-world situations.

However, there are also some challenges that need to be addressed when implementing interprofessional medical simulation cooperation in the metaverse. These include technical issues related to the design and implementation of the virtual environment, the need for high-quality simulations that accurately replicate real-world scenarios (making them accessible at different locations, even if with different equipment), and the need for a robust and reliable communication platform to facilitate interprofessional collaboration.

In summary, the use of the metaverse in interprofessional medical simulation cooperation has the potential to provide a unique and effective way to train healthcare professionals in an immersive and collaborative environment. However, it requires careful planning and implementation to ensure that it is effective and addresses the challenges associated with it.

Enhancing medical simulation based on cooperation in the metaverse requires a comprehensive approach that involves designing the virtual environment (to deploy also into a hybrid or "phygital" environment), developing high-quality simulations, and providing effective communication and collaboration tools. Here are some ways to enhance medical simulation based on cooperation in the metaverse:

- Design a realistic virtual environment: The virtual environment should closely mimic real-world hospital settings, including patient rooms, operating rooms, emergency departments, and/or outdoor environments. The virtual environment should also be designed to include various equipment and tools necessary for healthcare professionals to perform their tasks.

- Develop high-quality simulations: The simulations should accurately replicate real-world clinical scenarios and should be challenging enough to provide a learning experience. The simulations should also allow for different scenarios, including rare or complex situations that healthcare professionals may not encounter often.
- Use multi-disciplinary team-based scenarios: The simulations should be designed to promote collaboration between healthcare professionals from different disciplines. The scenarios should encourage communication and coordination among team members to achieve common goals.
- Incorporate innovative technologies: The metaverse allows for the use of innovative technologies like virtual and augmented reality, which can help healthcare professionals experience a simulated environment in a more realistic and immersive way. Additionally, the use of haptic technology can provide tactile feedback and enhance the realism of the simulation.
- Provide effective communication and collaboration tools: The virtual environment should provide effective communication and collaboration tools that allow healthcare professionals to communicate with each other during simulations. These tools can include audio and video communication, text chat, and virtual whiteboards.
- Incorporate feedback mechanisms: The simulations should have mechanisms for providing feedback to healthcare professionals on their performance during the simulation. This feedback can help healthcare professionals identify areas where they need improvement and work on those areas.

Enhancing medical simulations based on cooperation in the metaverse requires careful planning and implementation. By designing a realistic virtual environment, developing high-quality simulations, using multi-disciplinary team-based scenarios, incorporating innovative technologies, providing effective communication and collaboration tools, and incorporating feedback mechanisms, healthcare professionals can benefit from an immersive and effective learning experience.

Fig. 4. Representative e-REAL scenario designed for enhancing cooperation into a metaverse-based simulation (for aviation and space medicine) where some people are performing in a hybrid environment, while others are in a fully virtualized dimension whose components are digital tools and conversational avatars

Fig. 5. Conversational avatars are representative components of an e-REAL cooperative metaverse: By scanning the QR code, an avatar will appear and will perform a short self-introduction (Augmented Reality) making available an online calendar in order to book a meeting with a number of intelligent avatars ready to talk with real human beings

Fig. 6. Representative conversational avatars, that are digital humans enhanced by artificial intelligence from an e-REAL environment

4 BOOSTING DIVERSITY AND INCLUSION WITH THE XR TECHNOLOGIES IN THE METAVERSE

XR technologies can be used to create immersive and engaging experiences that encourage cooperation and collaboration among learners. At the same time, XR can be used to boost diversity and inclusion in the metaverse in various ways. e-REAL is a system designed with diversity, equity, and inclusion in mind. Firstly, XR can be used to create immersive experiences that represent diverse cultures and communities. This can help to promote cultural understanding and reduce prejudice

and discrimination. Secondly, XR can be used to create inclusive environments that cater to the needs of users with disabilities. For example, XR can be used to simulate a wheelchair-friendly environment or provide audio descriptions for users with visual impairments.

XR can also be used to promote diversity and inclusion by providing equal opportunities for users to participate in the metaverse. For example, XR technologies can be used to remove barriers to entry, such as physical location, by providing a virtual space where users can engage with each other. This can help to increase the diversity of users in the metaverse and promote inclusivity.

Engaging learners with diversity and inclusion [10] is essential for promoting a positive learning experience and creating an inclusive environment. Here are some ways to engage learners with diversity and inclusion:

- Creating a safe and inclusive environment is crucial to engaging learners with diversity and inclusion. Learners should feel that their contributions are valued and their experiences and perspectives are respected. Educators and trainers should establish ground rules that promote mutual respect and foster an environment that welcomes diversity.
- Using examples and case studies that represent a range of experiences and perspectives can help learners appreciate the diversity of the world around them. Teachers can use examples from different cultures, genders, religions, and backgrounds to help learners develop a broader understanding of the world.
- Encouraging open and honest communication can help learners share their experiences and perspectives. Teachers and trainers can facilitate group discussions that promote respectful dialogue and encourage learners to ask questions and share their thoughts.
- Active listening is an important skill for engaging learners with diversity and inclusion. Teachers can encourage learners to listen actively to their peers and acknowledge their perspectives and experiences.
- Creating opportunities for reflection and self-assessment can help learners identify their own biases and assumptions. Teachers can encourage learners to reflect on their experiences and perspectives and consider how those might affect their interactions with others.
- Providing resources and support can help learners engage with diversity and inclusion more effectively. Teachers can provide reading materials, videos, and other resources that promote diversity and inclusion. They can also connect learners with support services that help them understand and navigate issues related to diversity and inclusion.

Engaging learners with diversity and inclusion is essential for promoting a positive learning experience, like a medical simulation, and creating an inclusive environment by fostering a safe and inclusive environment, using diverse examples and case studies, encouraging open and honest communication, promoting active listening, creating opportunities for reflection and self-assessment, and providing resources and support, teachers and trainers can help learners engage with diversity and inclusion more effectively.

One way to promote a safe and inclusive environment is by setting clear expectations for behavior and communication. Trainers should emphasize the importance of treating all virtual patients and colleagues with respect and encourage learners to ask questions and seek feedback in a respectful and non-judgmental manner.

Using diverse examples and case studies—that XR contributes enormously to create: for example, by changing gender, age, or ethnicity to the avatars that are populating a simulation session—can also help learners to see the value of diversity and inclusion in healthcare and understand the unique challenges faced by different patient populations.

Active listening is another important skill that can be developed through extended reality-based simulation. Trainers can create opportunities for learners to practice active listening by incorporating role-playing scenarios where they must listen to a virtual patient's concerns and respond with empathy and understanding (changing for example specific attributes related to gender, age, or ethnicity in a way that is not feasible during a standard simulation). Reflection and self-assessment can also be powerful tools for promoting equity and inclusion by encouraging learners to reflect on their own biases and assumptions and consider how they can improve their interactions with diverse patient populations—that in an XR setting may vary more than in a traditional simulation.

Finally, providing resources and support can help to close collaboration, equity, and inclusion gaps in medical simulation. This could include access to cultural competency training, mentorship opportunities, and resources for addressing implicit bias. By incorporating these elements into extended reality-based simulation scenarios, trainers and educators can help to create a more inclusive learning environment and prepare healthcare professionals to provide high-quality care to diverse patient populations.

XR technologies, with e-REAL at the forefront, offer a unique opportunity to promote cooperation and boost diversity and inclusion in the metaverse. By creating immersive and inclusive experiences, XR can provide a safe and engaging space for users to interact with each other regardless of their physical location, race, age, or gender. The use of XR technologies can help to remove barriers to entry and promote equal opportunities for users to participate in the metaverse. Further research is needed to explore the potential of XR in promoting diversity and inclusion in the metaverse.

5   CONCLUSIONS

In conclusion, the concept of the metaverse, representing a potential shared virtual space for interactive experiences, has emerged as a pivotal focus in the ongoing digital revolution, particularly in the realm of education and training. The coalescence of extended reality and medical simulation within the metaverse heralds a transformative era for healthcare education. As we navigate the ever-evolving landscape of the metaverse, it is essential to recognize that multiple metaverses are currently under development, each offering unique possibilities for innovation. The synergy between medical simulation and the metaverse empowers educators and healthcare professionals to reimagine education and training. This article underscores the importance of addressing key questions concerning the metaverse's current state, its future trajectory, and its potential to enhance medical simulation while fostering inclusivity and diversity. As we stand at the intersection of technology and education, the metaverse beckons as a dynamic realm where the boundaries of traditional learning are expanded, enabling learners to engage in immersive, collaborative, and inclusive healthcare education experiences that will shape the future of the medical field.

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