

INTRODUCTION TO STEM AND THE METAVERSE **MSTEM** CHAPTER 1

METAVERSE-BASED STEM EDUCATION FOR A SUSTAINABLE AND RESILIENT FUTURE 2023-1-FR01-KA220-SCH-000151516





VAEV R&D





The Changing Landscape of Education in the 21st Century

Introducing STEM education and the metaverse

In today's rapidly evolving world, priorities shift to keep pace with these changes, and education is no exception. The 21st century has witnessed a massive surge in digital technologies, revolutionizing how we approach learning. Education is no longer just about acquiring knowledge; it's now focused on equipping students with the skills to navigate complex, technology-driven environments.



An emerging education force is STEM: Science, Technology, Engineering & Mathematics. STEM education is defined interdisciplinary approach an as to learning, integrating subjects of science, technology. engineering, and mathematics, focusing on real-world applications and problem-solving. Even though these subjects, for example mathematics, can be taught alone, the difference is that STEM education

altogether encourages applying the knowledge, therefore increasing the student abilities when it comes to critical thinking, creativity, and innovation.

Today's world is very well interconnected and technologydriven, for this reason, the vitality of STEM education, cannot be denied.







Industries all around the globe continue to evolve on a daily basis and therefore we're forced to adapt to these new technologies. As our adaption is a must, the demand for skilled professionals with a strong foundation in STEM subjects continues to grow, subjects ranging from climate change to healthcare advancement all



require solutions that are not only innovative but also multidisciplinary, that is the reason why STEM education is very important for all students all around the world. The metaverse is a virtual space, blending physical and digital reality offering interactive experiences. Metaverse is initially known to be in the entertainment



industry and the gaming industry, however, its rapid increase of popularity has helped it gain traction in education. Integration of STEM education and metaverse means to corporate STEM concepts into a virtual world of Metaverse where learners can

explore scientific models, collaborate in real time with an engaging 3D environment and simulate engineering problems. This interconnectedness of both STEM and metaverse opens up a world of possibilities with the promise of interactive and accessible learning experiences.



In this chapter, we're going to dive into the importance of STEM education and its benefits. We will also be discussing the Metaverse concept, its importance, and how it's linked to STEM education.





Benefits of STEM Education

Real World Applications & Hands on Learning

STEM education includes showing how taught material can be applied in real life situations. For example, in a class learning about renewable energy, students may end up designing their own solar-powered devices under the teacher's supervision. This application of solar-panel helps



students to experience firsthand on how science and engineering can solve environmental problems, and how these solutions are realistically applied in the real-world. Furthermore, hands-on learning refers to engaging students to actively participate while learning.



For example, instead of reading about electricity from the book, students are in a laboratory, reading from their book as well as building their own circuits and experimenting through the process. This does not only help students to understand vigorous concepts, but

it also allows students to be personally engaged with the matter, enabling them to apply their theoretical knowledge into practical applications. In such hands on learning, as students build circuits, they are able to detect their mistakes and therefore fixing it, giving them a sense of accomplishment.

Equality in Education through STEM Education

STEM education plays a crucial role in promoting equality in education by providing inclusive opportunities for all students, regardless of their backgrounds. In many traditional educational settings, certain groups may face barriers to accessing advanced courses or resources.







However, STEM initiatives actively work to remove these gaps by offering specific programs which are designed to support disadvantaged groups. For example, after-school coding camps aimed at girls or students from low-income families can open doors to careers in technology. Implementing STEM education

in school curricula means having hands-on, project-based learning, which levels the playing field for students with diverse learning styles. For instance, a project on building a robot allows students to contribute based on their strengths so some students may find themselves excelling in coding,



while other students find out they enjoy design, while some find they shine in teamwork. In the long run, this helps students to find out more about their learning patterns and their interests, which makes them more knowledgeable about what they want to end up doing when they become working adults. Such an environment, with wide collaboration,



belonging and promotes sense of а encourages the students to realize their skills. valuable Having inclusivity and accessibility through STEM education created equitable learning environments, this enriches educational experiences and prepares a group of educated students in diverse sectors capable of tackling multifaceted challenges.

Critical Thinking & Creativity in STEM Education

STEM education boosts students' critical thinking and creativity by immersing them in hands-on projects, as we've discussed earlier in this chapter. When students dive into these projects, they analyze information, evaluate evidence, and come up with solutions to the problems they encounter. This process encourages collaboration, allowing students to brainstorm together and share their ideas, which helps them blend their diverse perspectives into a cohesive solution.



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Moreover, STEM education incorporates various learning methods—like experimentation, open-ended questions, teamwork, and real-world connections—enabling students to think critically and express their creativity as they explore how what they're learning applies to real-life situations.



Other benefits of STEM education include motivating the students to explore a specific subject without supervision, on their own initiative, sparking curiosity and interest. STEM education encourages independent exploration by motivating students to dive deeper into subjects. For example, a student taking a class about astronomy may begin building models of planets or may begin to research space topics without any prompt from their teacher. Another benefit is the enhancement of teamwork as STEM projects in school require pupils to collaborate in teams, for instance in a robotics class, students may apply teamwork by focusing on different sections of their task. One student might focus on coding while another designs the hardware, teaching them the importance of working together.



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The Metaverse: Overview and Potential in Education

Metaverse is defined as a virtual-reality space in which users can interact with a computergenerated environment and other users. Metaverse progressing rapidly is and developing throughout the years, as а technology that involves immersive, interactive and 3D digital environments where users are able to interact with one another and virtual objects as well in a virtual hypothetical reality. Metaverse blends both the physical world as well as the digital world



together, offering an experience where people don't just view it but also are able to participate in it. When it comes down to the context of



education, the blending of metaverse technology and education is a breakthrough; new horizon of education which enables new, refreshing ways of both teaching and learning, breaking any limitation that physical classroom may have. In order to understand how metaverse can be blended in education,

It's vital to understand that metaverse offers a variety of technologies making a digital environment possible such as:

- Virtual Reality (VR): the computer-generated simulation of a 3D image or environment that can be interacted in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors.
- Augmented Reality (AR): Augmented reality is an interactive experience that enhances the real world with computer-generated perceptual information. Using software, apps, and hardware such as AR glasses, augmented reality overlays digital content onto real-life environments and objects.







 Artificial Intelligence (AI): Artificial Intelligence (AI) is an evolving technology that tries to simulate human intelligence using machines. AI encompasses various subfields, including machine learning and deep learning, which allow systems to learn and adapt in novel ways from training data.





• Chain technology: The chain technology is a decentralized, distributed and public digital ledger that is used to record transactions across many computers so that the record cannot be altered retroactively without the alteration of all subsequent blocks (elements of the chain) and the consensus of the network.

Virtual Reality (VR) creates interactive digital worlds which may be explored by students allowing them to experience circumstances that may be impractical in the real world. An example is students studying ancient civilizations may be able to have a walk in VR through a reconstruction of ancient Rome. Other students who study



oceanography may have a dive into different depths of the ocean through VR technology, without having the need to physically leave the classroom. Now, let's imagine an oceanography class where students use AR glasses to explore a 3D model of the ocean floor. They can zoom in to observe underwater topography, label different types of marine ecosystems, and interact with virtual marine species, studying how they adapt to their environment. In that case,



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Augmented reality (AR) is what enables this, overlaying digital elements onto the real world, better real-life environment creating a through interactive information. Furthermore. artificial intelligence is another main essential component which would be helpful in creating virtual tutors, learning platforms and adaptive automatic assessment tools. Lastly, Decentralized technology



helps make sure digital identities such as usernames and important documents like certificates and transcripts are safe and can't be faked or changed. Think of it like a super secure digital locker that keeps track of everything and makes sure no one can tamper with it.



For example, if a student earns a diploma in an online course, the chain technology stores the diploma in a way that anyone can verify it's real, but no one can change or delete it without permission.

Metaverse is starting to make its way into education, changing how teachers teach

and how students learn. There are platforms like virtual classrooms, immersive simulations, and game-like learning spaces that are helping to reach this change. For instance, Engage VR, a free application, which provides various tools for collaboration, such as immersive white boards, screen streaming, 3D virtual pens and spatial VoIP communication, allowing students join classes in a fully immersive setting where they can interact with their classmates and teachers as avatars. Other platforms, like AltspaceVR and Mozilla Hubs, are used for virtual events and group discussions, creating opportunities for students to learn together. These mentioned platforms, are digital spaces using the technology mentioned above, they don't just replace traditional classrooms but also they allow realistic simulations of complex processes such as science experiments which may be expensive or not doable in real life.





Learning with Metaverse VS Traditional Learning

It is essential to analyze and compare traditional learning and Metaverse learning methodologies to gain a deeper understanding of their distinct effects on student outcomes. Key factors to consider in this comparison include the learning environments they provide, the levels of interaction and engagement, opportunities for personalization and flexibility, the nature of collaboration, and issues related to accessibility and inclusivity. Additionally, cost and resource efficiency, as well as the impact on social and emotional development, are critical components that influence how each approach shapes the educational experience.

By examining these factors, educators and policymakers can make informed decisions regarding the integration of new technologies in educational settings, ultimately enhancing the learning experience for students.



Learning environment

Traditional Learning: Physical classrooms with face-to-face interactions between teachers and students. Desks, books, whiteboards, and lectures are common tools used in this setting. Students are typically passive recipients of information.

Metaverse learning: Occurs in virtual environments. With tools like VR and AR, students can explore 3D simulations, interact with avatars, and engage in hands-on virtual experiments.





Interaction and Engagement

Traditional Learning: Mainly focused on teacher-led instruction. While group work and discussions exist, fewer interactive elements exist when compared to digital environments.

Metaverse Learning: Highly interactive and allows students to actively engage with the content. Students can manipulate virtual objects, explore simulations, and participate in immersive experiences.

Personalization and Flexibility

Traditional learning: Has a one-size-fits-all approach, with set curriculums that may not accommodate to individual learning speeds or styles.

Metaverse learning: Offers personalized learning experiences. Students can learn at their own pace, repeat difficult concepts, or explore topics in more depth. There's capability of using AI-powered platforms can track progress and provide tailored recommendations to enhance learning.

Collaboration

Traditional Learning: Students collaborate in person through group work, presentations, and discussions. All of these include face-to-face interactions which help students develop their social skills, but they are fixed to the students found in the classroom.

Metaverse learning: Enables global collaboration. Students can work with peers from different parts of the world, engaging in virtual group projects or attending international seminars. This opens opportunities for global learning experiences that would be difficult in a traditional classroom setting







Accessibility and Inclusivity

Traditional Learning: Limited by location and resources. Schools in rural or underfunded areas may not have access to advanced materials, laboratories, or diverse learning opportunities.

Metaverse learning: Can overcome geographic barriers, making quality education accessible to students from different locations.

Cost and Resource Efficiency

Traditional learning: Requires significant investment in physical infrastructure, textbooks, and other materials.

Metaverse learning: Can reduce the need for physical resources by using virtual environments. Virtual labs and field trips can replace costly real-life counterparts.

Social and Emotional Development

Traditional learning: Emphasizes real-world social interaction, which is essential for developing communication skills, teamwork, and emotional intelligence.

Metaverse learning: offers virtual collaboration, however the concern is reliance on digital environments might limit real-world social skills and face-to-face interactions.





