



ORIGINAL RESEARCH PAPER

Metaverse Mastery: Unveiling the Magic of XR Technologies to Transform the Learning Experience of EFL University Students

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ABSTRACT

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Background and Objectives: The ever-changing and enigmatic future is taking form through a continuous wave of worldwide trends, advancements, and revolutionary ideas. Moreover, the rapid spread of the coronavirus and subsequent lockdown measures have accelerated the pace of technological advancements, significantly impacting multiple facets of our existence, employment, and connections. In the realm of learning, there has been an astounding and rapid transition from conventional classrooms to virtual platforms and groundbreaking advancements. Consequently, it becomes imperative for mankind to acknowledge and evaluate the profound influence of these developments, specifically within the domain of education. This innovative research project seeks to investigate the impressive capabilities of metaverse technology in addressing an unforeseen hurdle. Its main aim is to examine the deep influence of extended reality technologies on future education and assess if incorporating metaverse technology in learning will transform the higher education, generating notable progress and enhancing the quality of instruction.

Materials and Methods: The study aimed to comprehensively understand the research topic and its context by gaining insight into the participants' perspectives and experiences. To achieve this, a qualitative research was used with 63 purposefully selected participants. The participants included Iranian male and female EFL university professors, EFL university students, educational technology specialists, and futurists in science and technology. Data was collected by conducting focused-group discussions and episodic narrative interviews, as well as utilizing narrative inquiry methods on the Telegram network. Data collection continued until saturation was achieved, resulting in 25 participants for interviews and 38 individuals for narrative inquiry. To analyze the data and identify recurring themes, thematic analysis was conducted, involving initial coding, focused coding, and axial coding.

Findings: Findings revealed that metaverse technology plays a crucial role in the field of education and has a significant influence on higher education. Surprisingly, while analyzing the data, four main categories were identified, surpassing initial expectations. These categories include: 1) Empowering experiences: XR heightens sense of immersion, presence, and agency; 2) The immersive power of XR: Boosting enjoyment, interest, motivation, and self-efficacy; 3) Exploring boundaries of perception: XR triggers the illusion of body ownership and embodiment in virtual environments; and 4) The metamorphosis of the self: XR revolutionizes attitudes, behaviors, cognition, and physical body. Each of these categories represents the impacts of metaverse on future education. Understanding and embracing XR's impact on education is vital for educators, as harnessing the metaverse's potential benefits can greatly enhance teaching and learning experiences through more captivating and immersive environments.

Conclusions: The outcomes of this research carry significant implications for policymakers, educators, managers, leaders, practitioners, and all stakeholders involved in the field of education. They provide valuable insights into global trends, emerging technologies, innovations, and developments, and how they will likely shape the future of higher education. Given the rapid advancements in technology and the ongoing impact of the coronavirus pandemic, it is crucial to embrace these technologies and implement necessary changes in learning and teaching method to improve the quality of education. The hope is that this study will be a trusted source and offer guidance to future generations, helping them meet the evolving requirements of education.



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مقاله پژوهشی

فراشناخت دنیای مجازی: رمز گشایی قدرت فناوری های XR برای تحول تجربه یادگیری دانشجویان زبان انگلیسی

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چکیده

پیشینه و اهداف: آینده ناپایدار و پیچیده ای که توسط روند های جهانی، فناوری ها و پیشرفت های تکنولوژیکی در حال شکل گیری است، درک عمیق انقلاب چهارم صنعتی و فناوری های آن را ضروری می کند. امروزه، همه گیری کوید ۱۹ نیز پیشرفت فناوری را به ویژه در حوزه ی آموزش تسریع کرده و بر بخش های مختلف زندگی بشر تأثیر گذاشته است به گونه ای که حوزه ی آموزش، به ویژه، یک تغییر سریع از یادگیری سنتی به سکویای برخط را تجربه کرده است. این پژوهش به بررسی اثرات و پیامدهای فناوری متاورس، در مقابله با چالش های غیرمنتظره ی آینده می پردازد. هدف اصلی این مقاله بررسی این موضوع است که آیا فناوری های واقعیت گسترده، به عنوان یکی از اجزای سازنده ی زیست بوم متاورس، می توانند بر آموزش عالی آینده تأثیر بگذارند و آیا فناوری متاورس قادر است باعث ارتقاء کیفیت آموزش در آینده شود.

روش ها: تحقیق کیفی حاضر با هدف یافتن درک جامعی از موضوع تحقیق با بهره گیری از دیدگاه ها و تجربیات شرکت کنندگان صورت گرفت. برای دستیابی به این هدف، ۶۳ شرکت کننده ی ایرانی مرد و زن، شامل اساتید رشته زبان انگلیسی، دانشجویان رشته ی زبان انگلیسی، متخصصان تکنولوژی های آموزشی و آینده پژوهان حوزه علم و فناوری به صورت هدفمند با روش گلوله برفی از سازمان ها و موسسات آموزشی مختلف در شهر تهران انتخاب شدند. داده ها از طریق دو روش مصاحبه و روایت-پژوهی جمع آوری شد. جمع آوری داده ها تا دستیابی به اشباع ادامه یافت که منجر به انتخاب ۲۵ شرکت کننده برای مصاحبه ها و ۳۸ شرکت کننده برای روایت-پژوهی شد. به منظور تجزیه و تحلیل داده ها، محقق از روش تحلیل مضمون شامل کدگذاری باز، کد گذاری متمرکز و کد گذاری محوری استفاده کرد.

یافته ها: تجزیه و تحلیل یافته های تحقیق حاضر نشان داد که فناوری متاورس نقش بسیار مهمی در زمینه ی آموزش دارد. در نتیجه ی تجزیه و تحلیل داده ها چهار دسته مضمون اصلی شناسایی و استخراج شدند: (۱) تجارب توانمند: واقعیت توسعه یافته، حس غوطه ور شدن، حضور و عاملیت را افزایش می دهد، (۲) قدرت فراگیر: واقعیت توسعه یافته، باعث افزایش لذت، علاقه، انگیزه و خودکارآمدی می شود، (۳) کاوش در مرزهای ادراک: واقعیت توسعه یافته، توهم مالکیت بدن و تجسم را در محیط های مجازی ایجاد می کند، (۴) دگردیسی خود: واقعیت توسعه یافته، نگرش ها، رفتارها، شناخت و فیزیک افراد را متحول می کند. این دسته بندی ها به وضوح تأثیر فناوری واقعیت توسعه یافته را بر آموزش عالی آینده نشان می دهند. درک مزایای گنجلندن متاورس در آموزش، می تواند محیط های جذاب و فعال تری را در فضای آموزش عالی فراهم کند.

نتیجه گیری: نتایج این مطالعه کاربردهای مهمی برای سیاستگذاران، اساتید، مربیان، مدیران، رهبران، دانشجویان، دست اندرکاران و تمامی ذینفعان آموزش عالی دارد و باعث افزایش بینش در مورد روندهای جهانی، فناوری های نو ظهور، نوآوری ها و پیشرفت ها و چگونگی تاثیر آنها در شکل دهی آینده ی آموزش می شود. با توجه به پیشرفت های سریع در فناوری و به ویژه تأثیر بیماری کوید ۱۹ در آموزش، پذیرش این فناوری ها و ایجاد تغییرات لازم برای بهبود کیفیت آموزش بسیار مهم است. امید است که این تحقیق منبعی قلیل اعتماد و انگیزه ای برای مطالعات آتی در زمینه آموزش و تحول نظام آموزش عالی آینده کشورمان باشد.

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Introduction

The world is experiencing a rapid and significant change called the Fourth Industrial Revolution (4th IR), which is characterized by its unique features, vast scope, and technological advancements. This revolution is profoundly transforming key aspects of human existence, including lifestyle, employment, and social interactions, at an astonishing pace and with a broad impact [1]. Schwab's proclamation of the 4th IR marks an unprecedented shift in human history that surpasses all previous revolutions [2]. The distinguishing feature of this revolution is the merging of physical, digital, and biological technologies, which include artificial intelligence (AI), robotics, the internet of things (IoT), biotechnology, and nanotechnology [3]. These technologies are pivotal in driving and accelerating the 4th IR, impacting diverse sectors including industry, agriculture, medicine, economics, and academia [4, 5].

The Fourth Industrial Revolution, according to the World Economic Forum [6], is shaping various aspects of our lives and affecting our identity, privacy, ownership, consumer behavior, work-life balance, professional growth, expertise acquisition, social responsibilities, and interpersonal connections. Therefore, to understand the 4th IR, we must acknowledge our physical, emotional, cognitive, and spiritual aspects, as asserted by Schwab [2]. This gains importance as talks about the possible rise of the Fifth IR have begun. The evidence indicates upcoming technological revolutions, bringing about diverse changes and challenges. Despite the uncertain future, it is clear that significant disruptions will alter various aspects of human life. Moreover, the global community has already experienced transformative shifts due to the unprecedented coronavirus pandemic [7]. Lockdowns during the health crisis have led

to a significant increase in technology adoption, inducing widespread changes and diverse online activities across various domains in our society [8]. Nowadays, the use of technology in education is on the rise, reflecting a wider trend. Indeed, investing in the education sector to foster adaptability is necessary in a world demanding more IT expertise. However, underdeveloped nations face hurdles in their education systems, lacking vital skills. Notably, the current economy increasingly values skills, marking an important change in recent times [9].

Many facts indicate that the coronavirus pandemic and the emergence of Industry 4.0 have greatly affected education, leading to changes in policies, teaching techniques, and learning possibilities [10]. Reforming the education system and aiming for top-notch education has become crucial now. Hence, devising integrated and comprehensive strategies that meet the needs of the 4th IR is essential in order to nurture students who have a distinct blend of abilities, knowledge, and innovation, empowering them to make the most of the 4th IR. Without achieving this, there will be a halt in progress and lack of advancement. Ultimately, without a quality education that involves all stakeholders, including the public and private sectors, academia, and civil society, it is impracticable to effectively address this revolution. Lately, people in different fields, especially education, have been highly interested in metaverse technology. The metaverse is a digital ecosystem or structure created by the convergence of extended reality (XR) technologies, such as virtual reality (VR), mixed reality (MR), augmented reality (AR), and other technologies like artificial intelligence (AI), immersive digital space, and real-time communication. It has garnered global attention and become a topic of debate today.

Despite the challenges, the value of striving to integrate this technology is immeasurable. This study aimed to investigate the effects of XR technologies on education, with a focus on showcasing their potential and uniqueness as part of the metaverse structure. The objective was to exemplify how metaverse technology can improve education. Therefore, a fundamental question was raised: How will integrating metaverse technology in education impact the future, potentially catalyzing transformative changes and enhancing the quality of education in the current system?

This study examines the effects and significance of metaverse technology on education, highlighting four categories related to XR technologies. The aim is to showcase the potency of the metaverse in future education. It presents metaverse technology as a significant trend in the 4th IR, with distinct characteristics and vast possibilities for education in the future. The study reveals significant impacts and implications of metaverse, offering valuable perspectives for leaders, educators, policymakers, and all educational stakeholders. These findings broaden stakeholders' comprehension of the benefits that come from incorporating the metaverse in education, focusing on its ability to improve the quality of learning. This is especially crucial for education authorities in developed nations striving to deliver exceptional education. Additionally, the research underscores the metaverse technology's potential to facilitate decentralized education, aligning with the objective of attaining excellent educational benchmarks. This research aims to facilitate the integration of the metaverse into educational institutions, fostering advancement and innovation in education. It anticipates stimulating further exploration of technology integration and endeavors to serve as a reliable

reference and supportive resource for future generations, addressing evolving educational requirements.

Review of the Related Literature

The metaverse is a virtual world with different digital spaces for entertainment, socializing, and learning. It serves as a network of computer-generated environments where users can fully engage in activities like work, play, and education [11]. Recent advances in technology inch us closer to achieving the metaverse, a concept introduced by Stephenson in his book thirty years ago [12]. XR technologies are fueling the metaverse's expansion, transforming how we engage with the digital realm and unlocking new possibilities [13]. As it is shown in Fig. 1, metaverse is a blueprint for enhancing comprehensive human development. The rapid development of Internet communication techniques and hardware platforms, decentralization, the combination of virtuality and reality, and high human-computer interaction are the conspicuous characteristics of the metaverse [14].

By incorporating virtual reality and augmented reality, the metaverse expands upon traditional internet and social media platforms [15]. The metaverse aims to use technologies like 5G, blockchain, AI, and 3D graphics to create an interactive virtual version of the real world. It allows exploration through XR platforms like Meta [16]. Extended reality (XR) technologies, such as virtual reality (VR), mixed reality (MR), augmented reality (AR), range from computer-generated environments to physical reality without virtual elements [17]. Elbamby et al. [18] stated that the key difference among VR, AR, and MR is the method of integrating computer-generated content into the real world, supporting the same argument.

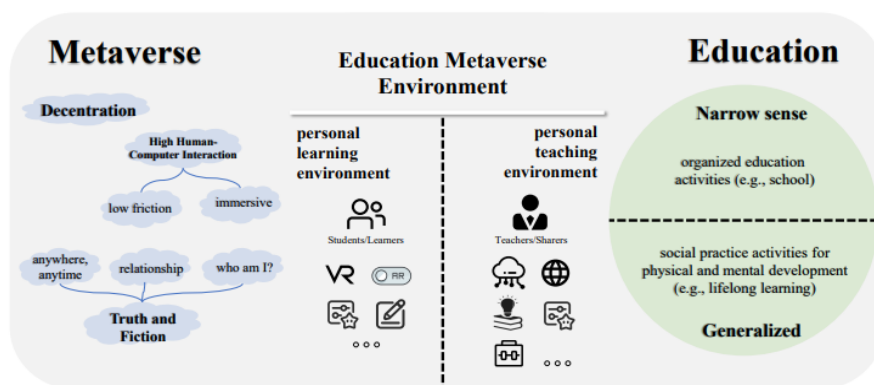


Fig. 1: The characteristics of metaverse and education

Source: Lin et. al, [14]

The study by Makransky and Lilleholt [19] found that 3D virtual learning environments, such as the metaverse, use VR, AR, and MR to recreate real-world settings for educational purposes. Makransky and Petersen [20] emphasize that AR, MR, and VR possess unique qualities such as immersion, interactivity, and invisibility, offering valuable benefits in education by creating sense of presence, control, and empowerment. Queiroz et al. [21] found that integrating XR learning environments leads to higher satisfaction and self-assurance among learners in their ability to acquire knowledge. Additionally, Kaplan-Rakowski and Gruber [22] suggested that language learners often struggle with complex texts, but immersive virtual reality has emerged as a motivating solution. Parong and Mayer's [23] research revealed that interactive virtual reality enhances learning by positively impacting emotions and cognition, improving learning outcomes. Furthermore, studies by Makransky and Klingenberg [24] and Makransky et al. [25] explored the emotional impact of immersive multimedia learning and revealed that highly immersive environments lead to increased presence and enjoyment. According to Wang et al. [26], XR's capabilities have the potential to enhance learning experiences by offering more realistic contexts compared to traditional classrooms.

Bailenson's [27] research showed that immersive virtual environments engage students and teachers effectively, which is challenging to replicate in real-life scenarios. Similarly, Makransky and Mayer [28] suggested that immersive virtual learning environments offer unique opportunities for experiential and situated learning that are typically not available in real-life situations. This is in line with the viewpoints of Di Natale et al. [29] who emphasized that immersive virtual learning systems offer authentic scenarios for engaging and contextualized learning, enhancing motivation and facilitating the transfer of knowledge. Numerous studies have indicated that the effectiveness of virtual learning experiences heavily depends on the technology utilized, which determines the level of immersion. For instance, the study conducted by Di Natale et al. [29] classified systems into three levels of immersion: non-immersive (desktop VR), semi-immersive (smart glasses or full dome), and fully immersive (head-mounted displays). According to Di Natale et al., [29], when using a head-mounted display (HMD) or a Cave Automatic Virtual Environment (CAVE), the perceived immersion in an environment is greater compared to a desktop virtual reality setup. Queiroz et al. [21] further explained that virtual reality systems track the user's head

movements and adjust the virtual environment accordingly, giving a 360° view of digital content. This creates an immersive experience using head-mounted devices, generating a computer-generated virtual space that appears realistic, as Kaplan-Rakowski and Gruber [22] described. A study by Wu et al. [30] revealed that HMDs in immersive environments are more beneficial than less immersive media, improving skill development, cognitive processes, and knowledge acquisition.

Makransky and Petersen [31] suggested that greater psychological presence in immersive environments enhances engagement and cognitive processing among students. This increased engagement requires more cognitive effort to comprehend learning materials. A study by Iriye and Ehrsson [32] suggested that individuals who feel a stronger connection to their virtual avatars have improved memory and self-awareness when recalling information. This indicates that incorporating multiple senses and our perception of our own bodies is essential in forming memories. Serino et al. [33] found that when participants experienced a congruent visuo-tactile condition, it led to a strong illusion of body ownership, self-location, and agency. This heightened their learning abilities, resulting in improved effectiveness and efficiency in the learning process. In an article, Schöne et al. [34] proposed that virtual reality has the potential to bring about changes in attitudes, brain function, and cognition by allowing individuals to embody different bodies. Liu [35] explores the 'Proteus Effect' introduced by Yee and Bailenson [36], which suggests that a person's behavior and attitudes in digital environments can be shaped by their virtual avatar. The appearance and actions of their digital representation can affect how they behave in both virtual and real-life settings.

Method

Participants

A group of 63 Iranian male and female, including English as foreign language (EFL) university professors, EFL university students, educational technology experts, and science and technology futurists, came together for an intriguing qualitative study. Out of the participants, 25 were selected to participate in two captivating interviews stages. The first stage involved a focused-group interview with 14 members, split into two sessions with four participant groups in each. The second stage involved conducting episodic narrative interviews with the remaining 11 participants. In addition, a total of 38 individuals participated in a narrative inquiry that was carried out using Telegram. Participants were recruited from various parts of Tehran, including research institutions, government organizations, technology companies, and universities. To ensure efficient engagement and effective data collection, a purposive and snowball sampling method was utilized. By involving experts and expanding the participant chain, data saturation was achieved, ensuring the study had an adequate sample size.

Instruments

This study aimed to explore the captivating world of the metaverse and understand its significant influence on the future of education. Two methods were employed to gather the data of the study. Firstly, interviews were conducted, which encompassed focused-group interviews and engaging episodic narrative interviews. Secondly, the narrative inquiry technique was employed to validate the data acquired from the interviews. The selection of the interview method was based on its convenience and usefulness in qualitative research. To collect diverse perspectives in a

structured setting, focused-group interviews were preferred, allowing for simultaneous discussions on the research topic. The episodic narrative interview was also effective in capturing personal stories and accounts, offering valuable insights into participants' actions and experiences. Narrative inquiry was particularly advantageous as it removed limitations such as time constraints and the requirement for face-to-face meetings. It encouraged participants to contemplate their experiences and share comprehensive insights through online networks, in real-time or at their own convenience. Different sets of questions were tailored for four groups of participants in both interviews and narrative inquiry to gather the required data. To ensure the content validity of questions, a team of experts diligently reviewed and approved them.

Procedure

In the first round of data collection procedure, interviews lasting 20 to 35 minutes, were recorded upon the participants' agreement. The conducted focused-group interview was split into two well-managed sessions, providing a non-threatening environment for participants to openly share their viewpoints and attitudes. The purpose, expected results, and advantages of participating in the interviews were clarified beforehand. The researcher then utilized probing questions to delve deeply into the areas of discussion, while carefully addressing any ambiguous remarks and seeking clarifications from the participants. The episodic narrative interview took place through various sessions, gathering comprehensive narrative accounts of participants' thoughts and experiences within specific episodes. In the second round of data collection, narrative inquiry established via Telegram group provided an environment for participants to engage in conversations. The inquiry focused on narrative affordances,

including distributed authorship, digital recombination, and reviewability. Distributed authorship allowed for multiple voices to contribute to a narrative, resulting in a nuanced portrayal of different perspectives. Digital recombination involved taking elements from existing content and placing them in a new context to create fresh interpretations. Reviewability encouraged storytellers to critically examine their stories to ensure they aligned with societal norms and reality.

Data Analysis

The researcher used a three-step coding process to analyze the data, which included initial coding, focused coding, and axial coding. The interviews were recorded and transcribed for analysis. All voices in the Telegram group were first transcribed and then along with the texts written there were analyzed. The data underwent thorough examination multiple times, focusing on identifying important ideas and messages at various levels, such as words, phrases, sentences, and paragraphs, that were relevant to the interviews and research questions. In the initial coding phase, the aim was not to fully analyze the data but to highlight key points and relevant sections related to the research questions. These sections were coded and accompanied by explanations. In the focused coding stage, important themes were identified from the initial coded sentences and given appropriate codes. The codes were carefully examined to differentiate similar codes from distinct ones. This process resulted in the collection of numerous early codes and patterns with different themes, which were then organized into primary categories. Analyzing the patterns within individual codes played a crucial role in forming the main thematic categories, thus leading to the axial coding stage of the data mining process.

Results and Findings

The study found that metaverse is a crucial technology that is having a significant impacts and implications on future education. As it is shown in Table 1, the analysis of the data resulted in the identification of four main categories related to XR technologies, demonstrating the opportunities of the metaverse in future education, each of which discussed below in details.

Theme 1: Empowering Experiences: XR Heighten Sense of Immersion, Presence, and Agency

Participants agreed that immersive virtual learning environments are highly beneficial for both educators and learners. As per an EFL university professor, these settings offer immersive experiences, encourage experiential and contextual learning, and provide interactive, genuine, and realistic opportunities. According to him, the degree of immersion depends on the resemblance of visual, auditory, and haptic cues to the physical

world. He conveyed his thoughts in the following manner:

The degree of engagement in virtual environments relies on elements such as precise tracking, high-quality visuals and audio, wide field of vision, and frequent updates. The level of user immersion or awareness of the virtual realm greatly influences the quality of their encounter.

He emphasized that the degree of total submersion sets apart a multifaceted cybernetic realm, observed on a computer screen and controlled with a mere mouse, from an extraordinary realm encountered through an awe-inspiring HDM or the mesmerizing CAVE, where the user is enveloped by large screens and views the environment with the aid of 3D glasses. In his perspective, an online learning environment with diverse elements may lack complete immersion, whereas the ‘Cave’ provides a partial immersive experience. On the other hand, the HDM takes immersion to another level by engulfing the user’s entire field of view with the wonders of the virtual realm. He elaborated on his explanation as follows:

Table 1: Metaverse impacts and implications on future education

Technology	Findings			
	Theme 1	Theme 2	Theme 3	Theme 4
Metaverse Impacts and Implications on Future Education	Empowering Experiences: XR Heightens Sense of Immersion, Presence, and Agency.	The Immersive Power of XR: Boosting Enjoyment, Interest, Motivation, and Self-Efficacy.	Exploring Boundaries of Perception: XR Triggers the Illusion of Body Ownership and Embodiment in Virtual Environments.	The Metamorphosis of the Self: XR Revolutionizes Attitudes, Behaviors, Cognition, and Physical Body.

The system classification's levels of immersion range from captivating to mesmerizing. Let's compare the immersive 'Cave' system, which showcases your actual body, to the HMD that ingeniously generates a virtual body. It allows you to seamlessly explore a virtual universe while observing your digital self, completely engulfing you in a vivid digital reality.

A futurist remarked that true immersion can be achieved by capturing real-life sensations, encompass a multitude of senses, and present an extensive range of representations, resulting in a magnificent experience. From this perspective, utilizing a HMD for education is superior to watching a 2D video because the HMD's immersive capabilities provide a captivating learning experience. He thought HMDs can revolutionize education by comparing immersive VR to desktop VR for proficiency development. He presented evidence supporting the effectiveness of instructional and scaffolding approaches in highly immersive settings, and elucidated how the combination of immersive experiences with effective teaching methods and scaffolding techniques produces valuable advantages. He summarized his thoughts in the following manner:

Effective instructional design and immersive virtual environments stimulate learners' cognitive processes in learners by encouraging information selection, organization, and integration, ultimately enhancing the overall learning process.

As per an expert in educational technology, learning in immersive environments has numerous benefits, such as a stronger sense of being present and agency. He highlighted the

psychological differences between non-immersive, semi-immersive, and fully immersive systems, emphasizing that the level of immersion directly impacts learner's agency and feeling of presence. The more immersive the experience, the more intense the sense of presence becomes. His opinion was articulated as follows:

The incorporation of presence and agency in immersive learning can greatly enhance students' learning. Presence induces a feeling of being in a virtual world, facilitating engagement and cognitive processing.

According to him, in a mesmerizing turn of events, as engagement spikes, students immerse themselves in the depths of their minds, investing a hefty amount of mental power in understanding. This grand display of mental exertion paves the way for a profound grasp of educational material, leaving an indelible mark on their memories, forever enhancing their cognitive prowess.

Theme 2: The Immersive Power of XR: Boosting Enjoyment, Interest, Motivation, and Self-Efficiency

In an awe-inspiring discussion on language skills, participants fervently accentuated the vital role of enthusiasm and joy in nurturing linguistic advancement. Emphasizing captivating teaching methods, they underscored the significance of comprehending how XR affect student emotions and achievements. As per a futurist, incorporating immersive XR tech in education can enhance language acquisition by increasing student engagement, motivation, and confidence. Here's a mesmerizing illustration of how the futurist articulated his concept:

Magical XR advancements enchant and mesmerize students, kindling an insatiable thirst for knowledge. Through immersive and interactive educational encounters, students embark on a captivating journey of discovery, fostering profound comprehension, boundless enthusiasm, and relentless motivation.

According to the futurist, by employing video cameras and HMD, one can forge an enchanting virtual realm where learning excels. This realm encompasses 3D items, avatars, and scenarios that amplify the learning process through imbuing a feeling of possessing a body, grasping spatial concepts, and effortlessly engaging with the virtual domain.

An EFL university student opined that XR technologies provide a superior and delightful educational encounter compared to real-world scenarios. He expressed that XR's virtual learning platforms offer a protected haven for skill development, self-assurance, and cultivating a positive self-image. As per the student, VR learning environments serve as a secure avenue to tackle challenging topics. Moreover, XR technologies stimulates problem-solving abilities by immersing students in realistic virtual settings, enhancing commitment, eagerness, and esteem, bolstering academic success in various disciplines. Here's an example of how the participant expressed his opinion with eloquence:

In virtual environments, students often experience complete absorption and presence by participating in game-like activities, enjoying involvement, and interacting with peers and instructors.

According to the student, virtual environments in XR tech enhance language

learning by creating realistic experiences, promoting natural language usage, and effective outcomes. He claimed that immersive virtual experiences provide learners with an exciting opportunity to enhance their language abilities. This cultivates a favorable approach to learning, resulting in heightened enthusiasm, attentiveness, and dedication. Educators can foster self-confidence in students, enabling a supportive atmosphere for continued academic involvement, he stated.

Immersive technologies have also been acclaimed by an educational tech expert for their captivating, interactive, and empowering attributes. A remarkable illustration of this groundbreaking innovation is the captivating domain of advanced virtual reality. This is the magnificent manner in which he expressed his ideas:

The headset is an essential instrument that allows users to completely immerse themselves in the virtual realm, utilizing head tracking technology to perceive and engage with a 360-degree virtual environment for an incredibly lifelike experience.

The educational technology specialist compared lessons in immersive systems like HMD's to those in less immersive systems like desktop VR or video. This showcased the significant influence fully immersive systems have on learners' attraction, motivation, and confidence. One of the fascinating statements uttered by the renowned specialist went as such:

By engulfing students and teachers in immersive environments, high-immersion systems can enhance their self-belief and learning outcomes. These systems eliminate distractions, stimulate multiple senses, and offer versatile representations.

The specialist recommended using HMD to deliver lessons because it enhances engagement and captivates students better than regular 2D videos. By providing more immersive experiences, such technology aims to offer realistic learning opportunities that boost student motivation and ultimately increase their confidence in their abilities.

Theme 3: Exploring Boundaries of Perception: XR Triggers the Illusion of Body Ownership and Embodiment in Virtual Environments

The captivating discussion among participants highlighted how XR's outstanding capability to foster a profound sense of bodily ownership and virtual embodiment, makes it an invaluable tool for improving learning, problem-solving, and critical thinking in various disciplines. A futurist highlighted that by leveraging the potential of the human intellect and XR advancements, educators and learners can gain remarkable control over their virtual avatars within educational settings. He expressed his idea in the following manner:

IVR technology provides an effortless means of transferring the illusion of body ownership to non-body objects or radically different bodies. This allows for a highly adaptable representation of the body that can be molded and transformed in unique ways.

An EFL university student eloquently elucidated the rubber hand illusion (RHI) experiment as a conduit for unraveling the visionary convictions of the futurist [37]. With utmost finesse, he vividly depicted a remarkable experiment that flawlessly demonstrates how the brain can be tricked into believing an outside object is part of the body, illuminating the mesmerizing mechanics of the

rubber hand illusion. one of the quotes he made was phrased like this:

The rubber hand illusion experiment manipulates our senses by stroking a fake hand and a real one together, creating confusion. This synchronized stimulation deceives the brain into accepting the fake hand as part of the person's body.

The university student observed that in rubber hand illusion experiment the brain merges synchronous yet separate inputs to form a unified experience. He stated that if visual and tactile stimulation were not in sync or happened at different times, the illusion would either not happen or would be weaker. Essentially, for the brain to perceive the fake hand as part of the participant's body, the visual and tactile inputs must be coordinated and synchronized, he conveyed.

An EFL university professor put forward the idea that when English language teachers and students are aware that an object does not belong to their body, they can still develop a deep sense of possessiveness towards it. His opinion was that by utilizing multisensory techniques, it would be possible to create illusions of being outside of one's own body. This was the manner in which he conveyed his viewpoint:

English language teachers and students can feel an unusual sensation of being close to or drawn towards a manikin's body by using it as a representation of a distant body in virtual environments, through synchronous stimulation.

According to him, the integration of visual and tactile input can give the impression of being located behind one's own body, enabling

a rear view of oneself. In other words, equipping educators and learners with video cameras and HMDs makes it possible to fully possess a body. Synchronizing the touch and sight of a manikin body generates a subjective feeling of ownership, enhancing involvement and immersion in XR learning, he mentioned.

Theme 4: The Metamorphosis of the Self: XR Leads to Alterations in Attitudes, Behaviors, Cognition, and Physical Body

Participants embarked on an exciting journey into XR technologies, motivated by their vast potential to transform education. They strongly believed in the power of these innovations to fundamentally change how knowledge is acquired, altering learners' cognition and behaviors. Notably, an educational technology expert proclaimed that adopting VR avatars can catalyze transformative shifts, impacting conduct online and in cyberspace. She fortified her reasoning by eloquently portraying her idea as follows:

In the virtual realm, individuals with attractive avatars are inclined to connect closely, while those with taller avatars exhibit greater assertiveness in negotiations than individuals with shorter avatars.

A remarkable demonstration of the profound impact of physical changes on a student's self-image and mindset was provided by a brilliant EFL professor, who ingeniously crafted a hypothetical situation to illustrate her concept. His articulate description of the concept was as follows:

In a scenario where non-native students learn from virtual representations of a native English teacher and a non-native English teacher

via a HMD, they display a stronger inclination towards the native teacher after observing their reflections for slightly over a minute.

The professor explained how stereotypes affect people's perceptions of virtual bodies, citing biases against non-native English-speaking teachers. He also showed how social norms in virtual environments shape individuals' behaviors in reality. He expanded upon his explanations by presenting them in greater detail:

Virtual embodiment promotes empathy, understanding, and positive interactions in real-life, especially in interpersonal communication settings, through adopting diverse identities.

One of the futurists discussed 'cortical body matrix' and its importance in maintaining body's spatial representation through multiple senses. The futurist stressed that the matrix is vital for our self-awareness and shapes our perception of and interaction with the outside world. He made a statement that went something like this:

The 'cortical body matrix' hierarchy suggests that claiming ownership of the whole body creates a sense of owning specific body parts, ensuring consistency in self-representation.

According to the futurist, embodying a virtual avatar can lead to our brains integrating sensory information from the virtual world similar to the physical world, resulting in a strong sense of presence and ownership over the virtual body, even though we are aware it is not real. This can create a genuine feeling of

occupying the virtual form, he conveyed. The futurist elaborated his discussion as follows:

Modifying the virtual body can alter our core beliefs, showing a shift in our ownership of it. This solidifies how virtual embodiment affects our mindset and behavior.

An expert in educational technology found that changing our sense of owning a body can significantly impact our thinking and emotions. He suggested using virtual embodiment to enhance mental health and questioned self-perception theories and stereotypes. The expert emphasized how our brain collaborates different regions to perceive the world using various senses, such as proprioception and vestibular, not just visual or auditory. These regions are crucial for directing actions and decision-making based on sensory input, he conveyed. He communicated his concept in the following manner.

The use of multisensory perception framework allows us to understand how our brains process sensory information from virtual environments, affecting cognition and behavior through changes in virtual body ownership.

In conclusion, an EFL university student highlighted the potential implications of XR technologies in creating illusions of body ownership and virtual embodiment within educational settings. He suggested that further research is necessary to fully understand the cognitive and emotional effects of such experiences in teaching, as well as their potential impact on learning outcomes. One of the sayings attributed to him was stated as follows:

Several investigations have explored the effects of body ownership illusions on physical changes, including shifts in voice pitch and alterations in speech patterns, among participants exposed to virtual reality settings.

He reported that the observed changes were only apparent in the synchronous condition, where the virtual body's movements were synchronized with those of the real body.

Discussion

Empowering Experiences: XR Heighten Sense of Immersion, Presence and Agency

The research discovered that immersive virtual learning environments offer unique and realistic learning experiences that are usually unachievable in real-life situations. This supports Bailenson's [27] concept that virtual learning offers distinct experiential learning compared to physical scenarios [28]. The participants shared their confidence in the captivating transfer of knowledge and the experiences generated by immersive virtual learning systems, leading to increased motivation. Similarly, Di Natale et al. [29] suggested that virtual learning environments promote contextualized learning and boost motivation, as well as transfer of knowledge. Participants' feedback confirmed that immersion levels in these environments depend on the technology employed, which can be high or low. Likewise, Makransky and Petersen [31] determined immersion levels depend on the hardware factors and the extent of sensory stimulation by the technology.

As per one EFL university professor, HMD and CAVE are deemed more immersive than desktop virtual reality environment. Likewise, Di Natale et al. [29] classified systems by immersion level: non-immersive (e.g., desktop

VR), semi-immersive (e.g., smart glasses/full dome), and fully immersive (e.g., HMDs). Similarly, Slater [38] stated that HMDs provide enhanced immersion with wider field of view and head tracking capabilities. Moreover, Queiroz et al. [21] described a system that tracks user's head movements in real-time, adjusting high immersive virtual environment to provide a comprehensive 360° view of digital content. Furthermore, Kaplan-Rakowski and Gruber [22] summarized that VR achieves high immersion through head-mounted devices, creating a spatially realistic 360° computer-generated virtual space. Additionally, Concannon et al. [39] Makransky and Lilleholt [19], and Lehikko [40] classified desktop virtual reality environments as non-immersive in their studies. The study findings revealed that utilizing HMDs in immersive VR enhances knowledge acquisition and skill development compared to less immersive desktop VR. A recent study by Wu et al. [30] compared immersive VR with desktop VR and traditional methods, finding immersive media to be more advantageous. The study recommended using HMDs for skill development and knowledge acquisition, as well as integrating immersive learning experiences and effective instructional design to improve cognitive processes and learning outcomes. Besides, Makransky and Mayer [28] cautioned that while immersive technology offers potential benefits, instructional designers and educators need to consider its specific advantages and disadvantages. However, Makransky et al. [41] and Parong and Mayer [23] identified cognitive load as a potential drawback when learning with immersive VR.

As per an educational technology specialist, learning in immersive environments provides benefits such as increased presence and agency. The level of immersion, whether non-immersive, semi-immersive, or fully immersive,

impacts the psychological experience of presence in virtual environments, he mentioned. According to Johnson-Glenberg [42] and Makransky and Petersen [31], the level of psychological presence is the primary distinction between more and less immersive environments, regardless of other factors like interaction and agency. These study suggested that immersive environments offer advantages for lessons requiring psychological presence and agency, especially in highly immersive settings. Moreover, greater presence leads to deeper cognitive engagement, requiring increased cognitive effort for comprehension. Renninger and Hidi [43], Deci and Ryan [44], and Mayer [45] mentioned that the immersion principle in multimedia learning draws from theories of interest, motivation, and multimedia learning. It suggested that increased psychological presence, when used well in instructional design, can enhance learning outcomes. According to Mayer's [45] social agency theory, higher presence prompts students to engage in deeper cognitive processing and exert more effort to understand the material.

The Immersive Power of XR: Boosting Enjoyment, Interest, Motivation, and Self-Efficiency

Participants believe that utilizing immersive XR technologies in education will enhance students' engagement, enthusiasm, internal drive, and confidence in their ability to learn. Important studies have revealed that incorporating XR learning environments leads to a boost in learners' enjoyment, internal drive, sense of control, and confidence in their ability to learn. Studies conducted by Makransky et al. [46] and Queiroz et al. [21] support the fact mentioned by participants. Lehikko [40] and Reilly et al. [47] have suggested that utilizing immersive learning

environments can enhance learners' self-efficacy by offering realistic hands-on or observational experiences. This can lead to an increase in learners' confidence and belief in their own ability to succeed. Kaplan-Rakowski and Gruber [22] proposed that numerous language learners struggle with the drive to read intricate texts, but high-immersion VR has been increasingly observed as a highly motivating solution. A study conducted by Parong and Mayer [23] discovered that immersive VR improves learning through encouraging positive emotional and cognitive mechanisms, leading to improved performances on tests evaluating learning outcomes. Makransky et al. [46] conducted a study and noted that the immersive VR group performed significantly better compared to the text group on two transfer tests that involved solving problems in a physical laboratory setting ($d = 0.54$, $d = 0.57$). They also reported higher levels of enjoyment ($d = 1.44$), intrinsic motivation ($d = 0.69$), and self-efficacy ($d = 0.60$) within the immersive VR group.

Kaplan-Rakowski and Gruber [22] conducted a study in which they compared the motivation of English as a Second Language (ESL) learners while reading a story with subtitles in VR (experimental group) versus reading the same story screencast in two-dimensions (2D- control group). The Wilcoxon signed-rank test showed that learners' motivation in the VR group was significantly greater when compared to the control group. Queiroz et al. [21] conducted two studies in which they compared the impact of educational immersive VR to traditional videos on conceptual knowledge and self-efficacy. The findings revealed that in Experiment 1, the immersive VR group had a higher score on self-efficacy compared to the desktop group. Additionally, in Experiment 2, the relationship between condition and self-efficacy was

mediated by learning agency, suggesting a potential mechanism that explains the impact of immersion on self-efficacy. Studies exploring the emotional effects of immersion in multimedia learning have shown that highly immersive environments lead to higher levels of presence [19] [41], enjoyment [24] [46] [48], and interest [25]. Wu et al. [30] conducted a recent meta-analysis that synthesized the results of 35 studies and found that highly immersive environments lead to greater levels of presence [19] [41], enjoyment [24] [46] [48], and interest [25].

Exploring Boundaries of Perception: XR Triggers the Illusion of Body Ownership and Embodiment in Virtual Environments

The study found the XR technology's potential to improve education through creating a virtual sense of embodiment and ownership of one's body, as participants showed captivation with the brain's distinction between their body parts and external objects, offering promise for educational uses. Numerous studies have also delved into the understanding of how the brain perceives and represents the body [49-51]. For example, 'Homuncular flexibility' refers to the brain's ability to adapt to different body arrangements and control an unfamiliar body. An expert in educational technology proposed that employing multisensory techniques may deceive the brain into perceiving a strong sense of possession over objects unrelated to their physical body. Likewise, Armel and Ramachandran [52] discovered that people can develop a strong attachment to an object, regardless of it not being a part of their body. Numerous research has been explored virtual embodiment technology and the elements that can generate illusions of body ownership [53][33][54][34][55]. For example, Guterstam et al. [53] employed a HMD to generate illusions of detachment by utilizing multisensory techniques.

An educational tech expert suggested simulating physical proximity through synchronized stimulation using a manikin in virtual settings, enhancing teacher-student engagement. Similarly, Kilteni et al. [56] induced an out-of-body illusion by stimulating participants' backs and stroking a manikin's back, leading to a feeling of ownership and presence in front of the manikin's body. An EFL university professor proposed creating an illusion for teachers and students, enabling them to perceive themselves from behind by synchronizing visual and tactile cues with their real physical body. In a similar manner, Penaud et al. [54] replicated this approach, with participants situated in front of video cameras that impersonated their own perspective. The experimenters stroked the participants' chests while simultaneously matching the strokes on the cameras. Consequently, participants experienced the sensation of being touched from behind their actual physical body. By combining visual and tactile cues in synchrony, the participants felt as though they were positioned behind their own body. Iriye and Ehrsson [32] discovered that individuals with a strong sense of ownership over their virtual avatar performed better in memory tasks and were more self-aware during recall. These findings emphasize the role of multiple senses and one's own body representation in forming episodic memories.

A futurist suggested that by utilizing specific technologies such as video cameras and HMDs, individuals can experience a sense of full physical ownership by observing a manikin body instead of their own during teaching and learning. This aligns with the beliefs of Slater and Sanchez-Vives [55], who argued that a wide field-of-view stereo HMD is necessary for individuals to see their virtual body with head tracking. Serino et al. [33] and Slater et al. [57] employed a HMD named Fakespace Wide5 to

investigate full body ownership in virtual reality, wherein participants observed a virtual body in sync with their actual body, from a first-person viewpoint. The HMD featured wide field-of-view and head-tracking technology, enabling participants to perceive the virtual body coinciding with their real body's position when looking downwards. The futurist discussed viewing avatars from off-center and believed that even with different genders, people still feel connected to their virtual selves.

The Metamorphosis of the Self: XR Leads to Alterations in Attitudes, Behaviors, Cognition, and Physical Body

The study concluded that incorporating XR technology into education can create a feeling of owning a different body, leading to potential impacts on attitudes, behaviors, cognition, and physical body. According to Schöne et al. [34], virtual reality can potentially induce changes in attitudes, behaviors, brain function, and cognition by embodying a different body. In a study, Liu [35] explored the concept called the 'Proteus Effect' introduced by Yee and Bailenson [36]. The Proteus Effect suggests that people's behavior in virtual settings is influenced by their digital avatars. Liu's study found that individuals with attractive avatars were more likely to approach others, while those with taller avatars displayed more aggression. This shows how a person's digital representation affects their behavior online and offline. One of the university professors used a scenario to illustrate how changes in an individual's real body can impact their self-perception and attitudes. Beaudoin's study [58] discovered that stereotypes have an impact on how individuals perceive and behave towards their changed body ownership. That is, people tend to conform to societal expectations linked to the body they possess, which influences their actions and attitudes. Devine and Elliot [59]

suggested that teachers may show implicit bias against non-native English teachers, assuming that native English speakers are better at communication. The scenario described, where teachers exhibit implicit bias against non-native English speakers, is commonly referred to as language bias. The Proteus Effect, as described by Liu [35], is based on Self-perception Theory [60], which suggests that attitudes are formed through self-observation. Studies by Groom et al. [61] and Hershfield et al., [62] support this theory by placing participants in behavioral situations.

Participants believed that body ownership and agency over a virtual body goes beyond surface-level illusion, impacting cognitive processing and extending beyond mere perception. Banakou et al. [63] and Llobera et al. [64] suggested that the cortical body matrix plays a vital role in body ownership and agency over a virtual body. It influences cognitive processes and sensory signals related to body ownership and agency, maintaining consistency between different aspects of the self and the body representation. Changes in virtual body

ownership can impact sensory perception and sense of self, emphasizing the significance of the cortical body matrix in cognitive processing and self-unity. Osimo et al. [65] found that using virtual reality to swap bodies with a virtual representation resulted in improved mood and potential effects on emotional well-being and cognitive processes like self-reflection. Additionally, research also looks at how body ownership illusions can impact the physical body. Overall, these findings show that altered body ownership can have a significant influence on individuals' psychological well-being and cognitive functioning. Banakou and Slater [66] discovered that perceiving and synchronizing movements with a virtual body creates a sense of control over speech. Voice frequency shifted higher after exposure in the synchronous condition, indicating a new motor plan for speech. This effect was not observed in the asynchronous condition.

Fig. 2 illustrates the depiction of future education in relation to the metaverse, as discussed by the participants.

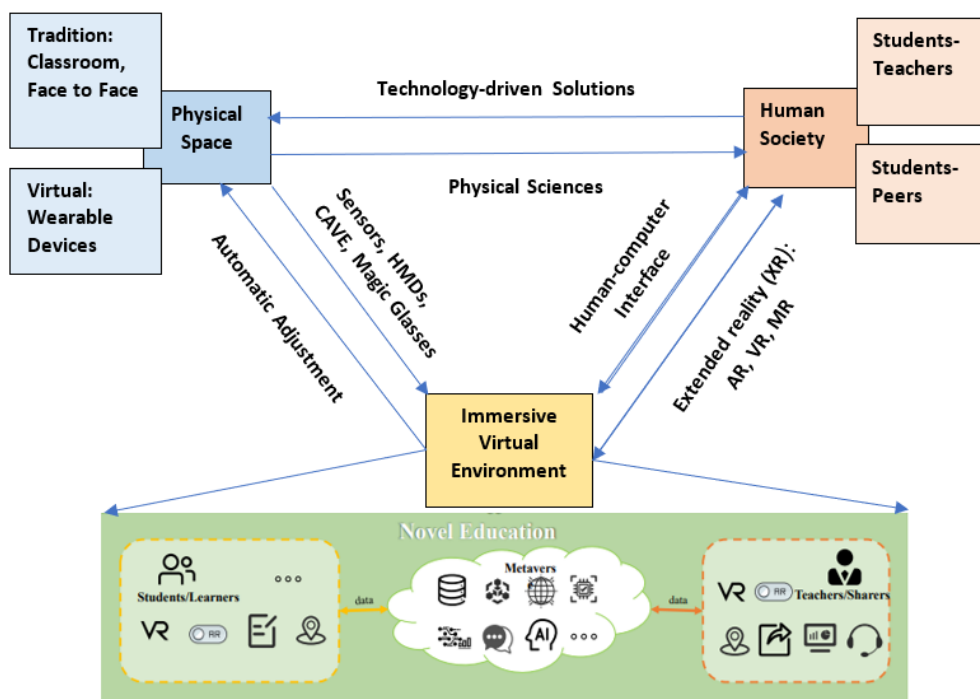


Fig. 2: Envisioning a portrayal of future education, integrating the metaverse

Conclusions

According to the literature, XR and 3D technologies have been crucial in driving advancements in various fields including medicine, chemistry, engineering, education, and others for numerous years. Previously, XR technologies were expensive and limited in use. Now, with advanced tech like high-resolution screens and motion sensors, XR is becoming more accessible for everyday use in various settings. XR is transforming life, work, and social interactions, making society increasingly reliant on technology. This uncertainty demands constant adaptation and lifelong learning. The world also faces other problems such as rising globalization, ongoing inequality, environmental deterioration, public health issues, and political upheaval. In order to successfully confront the global challenges and ensure success for everyone in the future, individuals must possess essential skills such as creative thinking, critical reasoning, metacognition, problem-solving abilities, effective communication, collaboration and understanding of global citizenship. It seems clear that there is an urgent need for a significant overhaul of the education system, in order to prepare young students for success in the face of the swift and continuous changes we are experiencing in technology, the economy, and society. Therefore, recreating the education system is necessary to achieve this goal.

It is important to acknowledge some limitations of this study. Firstly, the research focused solely on the educational applications of metaverse technology and did not explore its potential drawbacks or challenges. Future studies could delve into the potential risks or limitations associated with the integration of XR in educational settings. Additionally, the study relied on a specific sample size and context,

thus limiting the generalizability of the findings. Further research with diverse populations and educational settings can provide a more comprehensive understanding of the implications of metaverse technology in education.

However, the findings of this study have important implications for educators and policymakers. Understanding the impact of metaverse technology on education can guide the development of pedagogical practices and curriculum design that effectively incorporate XR experiences. By embracing XR technology, educators can create immersive and interactive learning environments that cater to the needs and preferences of today's digital-native learners. Policymakers can provide support and resources for the integration of metaverse technology in educational institutions, fostering innovation and preparing students for the digital future. Additionally, the findings call for professional development programs to equip educators with the necessary skills and knowledge to effectively leverage metaverse technology in the classroom. The results of this study suggest that the metaverse has a significant influence on the future of education by providing more engaging and immersive environments. It not only presents exciting opportunities for educators, content creators, and developers of educational materials to enhance teaching and learning across various domains, but also prepares global communities for the future. Furthermore, it offers valuable insights for policymakers, educators, managers, leaders, practitioners, and stakeholders in higher education. This research is anticipated to serve as a credible resource for future inquiries in the field of education.

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Conflicts of Interest

The author has no conflicts of interest.

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