MILES Virtual World: A Three-Dimensional Avatar-Driven Metaverse-Inspired Digital School Environment for FEU Group of Schools

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ABSTRACT

Immersive technologies have generated significant interest across various academic disciplines. The necessity for more authentic, interactive, and immersive artificial environments led to the growing popularity of the metaverse. Unfortunately, not all metaverse types have been broadly covered in educational research. This inadequacy highlights a gap in understanding the potential benefits and drawbacks of metaverse technologies for education. To address this research gap, we created a metaverse called "MILES Virtual World" that embodies the concepts of lifelogging and mirror worlds. Following the principles of the Embodied Social Presence Theory, the application allows students to socialize through customizable avatars and engage in a variety of activities that closely resemble those in the physical world. We adopted a mixed-method approach using a convergent parallel design to evaluate the application. Our quantitative analysis reveals that students feel highly present and engaged in the virtual environment, with a sense of agency and immersion. It also underscores the importance of enhancing embodiment and copresence to create more effective virtual world experiences and opportunities for social interactions. Meanwhile, our qualitative analysis uncovers several underlying subthemes, including avatar customization, identity exploration, virtual items, communication, entertainment, autonomy, freedom of expression, realism, challenges, shared experiences, and a sense of belonging within the metaverse. Overall, our study provides valuable insights into the potential of metaverse technology in the educational context, and how it can be harnessed to create more effective and engaging academic experiences for students.

CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI); HCI design and evaluation methods; Usability testing; • **Applied computing** → Education; Interactive learning environments.

KEYWORDS

Metaverse, Digital Learning, Higher Education, Immersive Technology

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1 INTRODUCTION

Concurrent with the COVID-19 pandemic, digital learning has emerged as a crucial and permanent aspect of modern education [1-3]. Digital learning is a broad term for educational approaches that deliver learning content via digital technologies, such as computers, mobile devices, software, and the Internet. It also encompasses various forms of online-based and computer-assisted instruction tools, including virtual classrooms, remote collaboration software, online learning platforms, educational applications, and multimedia resources [4-7]. When conjoined with the appropriate pedagogies, digital learning technologies can provide interactive experiences that can encourage students to participate and take an active role in their learning. For instance, teachers may integrate digital games into classroom instruction and use them in conjunction with instructional strategies that emphasize the development of critical thinking, problem-solving, and metacognition [8-10]. There is also indicative evidence that leveraging digital learning solutions provides learners with an opportunity to engage in active learning inside and outside

the classroom. One example is fusing extended reality technologies like virtual and augmented reality with pedagogies like experiential and inquiry-based learning. This amalgamation provides students with immersive learning experiences that promote a deeper and more meaningful understanding of the learning material [11, 12]. Although most authors used them interchangeably, the academic utilization of these instructional technologies is more accurately classified as immersive learning instead of digital learning.

Immersive learning refers to a learning experience that takes place in a simulated or artificial environment. These learning environments are rich in emotions, perceptions, and sensations with a particular emphasis on the interaction between virtual and physical objects as well as learning content and context [13]. Immersive technologies, such as augmented and virtual reality applications, are already employed to enrich the teaching and learning process across all levels of education systems. In addition, a systematic review concluded that immersive applications have generated significant interest across various academic disciplines [14]. Students exhibit a stronger preference for these technologies because of the greater sense of authenticity and interactivity. In immersive learning, authenticity means replicating real-world experiences and settings in the virtual environment, while interactivity means enabling learners to interact with virtual objects and characters. These characteristics are crucial in creating immersion or the degree to which learners feel present in a simulated environment [15-17]. For instance, authenticity creates a sense of realism and credibility that helps to suspend disbelief and encourage learners to fully engage with the experience. On the other hand, interactivity develops a sense of agency and control that can lead to higher levels of engagement and motivation. The necessity for more authentic, interactive, and immersive artificial environments led to the growing popularity of the metaverse.

The concept of the metaverse was derived from depicting a new plane of existence separate from and parallel to the physical world. It first appeared in Neal Stephenson's 1992 science-fiction novel "Snow Crash" where the characters become digital avatars in a three-dimensional (3D) virtual world. This literary work together with audiovisual works (e.g., video games and films) as well as various research projects have laid the foundation for the popularization of the metaverse in contemporary times [18-22]. Recent metaverse ecosystems have been shaped by the emergence of innovative technologies, such as 3D reconstruction, holography, extended reality, blockchain, cloud computing, and artificial intelligence. In education, virtual reality (VR) is the most studied technology within the metaverse ecosystem [23]. Despite the popularity of this technology, the assumption that the metaverse is solely reliant on head-mounted displays for users to enter the virtual world is a common misconception. As explained [24], the categorization of the metaverse includes four distinct groups: augmented reality, lifelogging, mirror worlds, and virtual worlds. Among these metaverse types, lifelogging and mirror worlds are the least frequently used metaverse types in education [25]. This inadequacy highlights a gap in understanding the potential benefits and drawbacks of these metaverse types for education. It also limits our ability to fully explore the potential of the metaverse as a valuable educational tool and thus warrants further investigation. To address this research gap, we created a metaverse called "MILES Virtual World" that embodies

the concepts of lifelogging and mirror worlds. The virtual world serves as a digital school environment where students can socialize through customizable avatars and engage in a variety of academic activities that closely resemble those in the physical world. This study holds significant importance as it delves into the social aspect of the metaverse, an area that has received little attention in educational research. Most scholarly investigations have concentrated on the pedagogical and learning aspects [23, 25], making this study a valuable contribution to the field. It also paves the way for further research into the potential of metaverse technologies in education.

2 THEORETICAL FOUNDATIONS

The concept of the metaverse revolves around the establishment of a virtual shared space in which individuals may interact with one another in real-time via digital avatars. As exhibited by prior works, this space can be used for a wide range of activities, including gaming [26], communication [27], marketing [28], education [29], and commerce [30]. These metaverse projects highlight that the success of this technology hinges upon its ability to effectively facilitate and enable social interaction within the virtual domain. Consequently, it is imperative to acquire a comprehensive comprehension of human behavior and interaction in virtual spaces.

The theoretical foundation of this study was based on the Embodied Social Presence Theory [31]. This theoretical framework posits that individuals' perceptions of the virtual environment in which they interact are significantly influenced by how they are embodied within that space. In this context, embodiment refers to the representation of a user's physical body within a digital environment. From the standpoint of telepresence, the physical body bears a resemblance to the technologies we employ in that both serve as intermediaries between the mind and the external environment, enabling communication and interaction [32]. The theory also argues that the perception of an embodiment can significantly impact an individual's cognitive engagement with their environment [33], influencing their level of attention and immersion within the shared activities and communication acts. Empirical evidence also exists regarding the impact of virtual embodiment on emotional reactions to virtual stimuli [34]. Augmenting emotional responses is crucial in numerous human-computer interaction applications, especially when designed for educational purposes. This necessity is attributed to the significant role of emotions in influencing cognitive processes and learning outcomes. By heightening emotional engagement, the virtual embodiment has the potential to facilitate deeper and more effective learning experiences, which can have positive implications for the acquisition and retention of knowledge [35].

The tenet of the Embodied Social Presence Theory also underscores the importance of goal-directed shared activities as a means of promoting social interaction within virtual environments. Engaging in communal activities involves working together towards a common goal, which fosters a sense of shared purpose and collaboration and helps individuals develop a sense of connectedness, trust, and mutual understanding. This shared experience can lay the foundation for stronger social relationships [36]. These digital connections play a critical role in virtual worlds as they enable individuals to connect with others and build communities in

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online environments. The virtual world offers a unique platform where individuals from different geographical locations, cultural backgrounds, and social contexts can interact and establish relationships without the constraints of physical proximity. Having a sense of belonging and social support can be particularly important for individuals who may feel socially isolated or disconnected in their offline lives [37]. Nevertheless, users do not actively pursue interpersonal relationships in a virtual world, but rather these connections emerge organically. Beyond engaging in shared activities, it is also important for individuals to engage in mundane activities and events that they would typically conduct with others in their offline everyday lives [38]. These activities can help to simulate a sense of normalcy and familiarity between individuals who have no pre-existing offline relationship.

In summary, the Embodied Social Presence Theory influenced the development of our metaverse in two ways: avatar embodiment and social relationship formation. Avatar embodiment allows inhabitants of the virtual world to create and control their digital personas that serve as a representation of themselves within the parallel environment. This embodiment enables users to experience a sense of ownership and agency over their avatars thus contributing to a heightened feeling of presence within the virtual world. Meanwhile, fostering social relationships via mundane activities creates opportunities for metaverse users to engage in collaborative tasks with one another. By providing such shared activities, the metaverse can facilitate the formation of social relationships between them, contributing to a sense of community and belonging within the virtual realm.

3 MATERIALS AND METHODS

3.1 Project Rationale

MILES Virtual World is a metaverse project that falls under the umbrella of the Mastery-based Individualized Learning Enhancement System (MILES) initiative of selected Far Eastern University (FEU) campuses, such as FEU Institute of Technology, FEU Alabang, and FEU Diliman (hereinafter referred to as FEU Group of Schools). This educational tactic was launched in July 2020 as a response to the online learning challenges induced by the COVID-19 pandemic. One primary challenge that has emerged is the difficulty in maintaining student engagement and motivation in a virtual setting [1]. With the absence of face-to-face interaction and the distractions of being in a home environment, students found it challenging to stay engaged and invested in their online coursework. The fundamental goal of MILES is to create an individualized online learning environment that can help students achieve a level of mastery by tailoring the learning experience to their unique needs and preferences. Additional applications were developed to extend MILES through the years, such as the MILES Network Map, MILES Incentives, MILES Last Course Access Report, Credentials, Briefcase, M-Flix, and MILES Virtual World.

3.2 MILES Virtual World

One of the key applications in the MILES ecosystem is MILES Virtual World – an educational metaverse that serves as a digital school environment for the FEU Group of Schools. Following the principles of the Embodied Social Presence Theory, the metaverse allows students to socialize through customizable avatars and engage in a variety of curricular and extracurricular activities that closely resemble those in the physical world. The metaverse can be conveniently accessed through smartphones, eliminating the restrictions posed by the dependence on head-mounted displays as experienced in virtual reality applications. Despite common assumptions, the use of a display device to access a virtual world is not a necessary feature of the metaverse. Rather than virtual reality, MILES Virtual World embodies the features of mirror worlds and lifelogging. The concept of a mirror world in the metaverse involves the creation of a digital twin of the physical world that replicates real-world objects and environments in a virtual space. This feature was achieved by building virtual replicas of three campuses as initially exhibited in the MILES Virtual Tour (i.e., the lite version of our metaverse) [39]. The virtual replica of the campuses provides students with an immersive experience that blurs the line between the physical and digital realms. Meanwhile, the lifelogging component allows for a deeper level of self-reflection and self-awareness as students can review their academic accomplishments. However, this feature is presently limited as it only relies on the automated recording of students' actions and experiences in the virtual world. As MILES Virtual World is connected to MILES Credentials, the academic progress obtained from curricular activities is readily available.

3.3 Metaverse Evaluation

The evaluation of MILES Virtual World adopted a mixed-method approach using a convergent parallel design. Although this research design has many purposes [40], it was employed in this study to illustrate quantitative results with qualitative findings. Both quantitative and qualitative instruments were developed based on the factors related to the tenets of the Embodied Social Presence Theory, such as embodiment, copresence, agency, immersion, and social relationship (see Table 1). The evaluation was conducted on February 10 after incorporating the feedback gathered from a series of public beta tests (see Figure 1). A total of 52 students enrolled in an information technology program specializing in animation and game development participated in the evaluation. The same set of students participated in the evaluation of the MILES Virtual Tour [39]. Each student installed the application on their smartphone and played for at least one hour at the same time while at home. A self-administered survey using Google Forms was sent after the session. Descriptive statistics and thematic analysis were used to report and explore the quantitative and qualitative data, respectively.

4 RESULTS AND DISCUSSION

4.1 Quantitative Findings

Table 2 shows the results of the survey measuring students' perceptions of various aspects of their metaverse experiences. The survey included five dimensions, namely Embodiment, Copresence, Agency, Immersion, and Social Relationship. The mean values of each dimension were calculated to provide an overview of participants' perceptions. According to the results, copresence received the highest mean value of 4.48 ± 0.50, indicating that participants felt a strong sense of being present in the virtual environment alongside others. Agency closely follows it, with a mean value of 4.35 ± 0.65, suggesting that participants felt a sense of control over their

Figure 1: The Beta Test 300.

Table 1: Constructs and Definition Used in the Research Instruments

Constructs	Definition	Related Studies
Embodiment	The degree to which users feel that an artificial body (e.g., digital avatars) is a representation of themselves in a virtual world.	[31, 32, 35]
Copresence	The degree to which users perceive themselves and other users as present in the same virtual space with interactions in real-time.	[31, 37, 41]
Agency	The degree to which users believe they have a sense of ownership and control over their actions in the virtual environment.	[35, 42, 43]
Immersion	The degree to which users are mentally and emotionally absorbed in their experience while in the computer-generated world.	[15, 16, 18]
Social Relationship	The extent to which users perceive that connections within the virtual environment are perceived as meaningful and valuable.	[27, 37, 38]

actions in the virtual environment. Immersion received a mean value of 4.13 ± 0.78, indicating that participants felt fully engaged in the virtual environment. Embodiment received a mean value of 3.94 ± 0.89, indicating that participants felt a moderate sense of being embodied within the virtual environment. Finally, Social Relationship received the lowest mean value of 3.91 ± 1.02, suggesting that participants felt a weaker sense of social connection with others in the virtual environment. Overall, these results suggest that participants felt highly present and engaged in the virtual environment, with a sense of agency and immersion. However, they felt less strongly embodied and socially connected. These findings may have important implications for the design and development of metaverse experiences, particularly in terms of enhancing social presence and embodiment.

4.2 Qualitative Findings

Table 3 presents the results of the thematic analysis, which shows the underlying subthemes of the factors used to evaluate the MILES Virtual World. The construct of embodiment was associated with three subthemes: avatar customization, identity exploration, and virtual items. Students expressed satisfaction with the ability to customize their avatars although they suggested the functionality to experiment with different identities. They also appreciated the virtual items and recommended adding more to the marketplace. Meanwhile, communication and entertainment were found to be

the subthemes of the copresence construct. Students found communication with other users challenging because of the absence of a voice communication feature. They were also looking for more virtual activities and minigames that would keep them entertained while in the virtual world. For the agency construct, autonomy and freedom of expression emerged as subthemes. It was found that students valued the freedom to make choices and act on them within the digital realm. They also appreciated the ability to express themselves without censorship. On the other hand, the immersion construct also had two subthemes: realism and challenges. Students appreciated how the campuses were replicated in the virtual world. However, they recommended increasing challenges to mimic the mental demands in the classroom. Finally, the social relationship construct was linked to two subthemes: shared experiences and a sense of belonging. Students found that shared experiences with other users were also an essential aspect of the virtual world. They welcomed the ability to connect with others online and proposed adding more opportunities to do so.

4.3 Discussion and Implications

The implications of our quantitative and qualitative findings are relevant to the design and development of metaverse in educational settings. Specifically, our study highlights the importance of enhancing embodiment and copresence to create more effective virtual world experiences. User embodiment within a multi-user

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Table 2: Constructs and Definition Used in the Research Instruments

Constructs	Mean	SD
Embodiment	**3.94**	**0.89**
I feel like my digital avatar accurately represents me in the virtual world.	4.09	0.81
When I control my digital avatar, I feel like I am controlling my own body.	3.98	0.77
I feel a strong connection between my physical body and my digital avatar.	4.08	0.82
I am satisfied with how my digital avatar looks and moves in the virtual world.	3.62	1.07
Copresence	**4.48**	**0.50**
I feel like I am interacting with other users in real-time in the same virtual space.	4.47	0.50
The virtual world feels like a shared space where we are all present together.	4.51	0.42
Other users' actions feel like they are happening at the same time and place as my own.	4.49	0.48
I feel co-present with other users in the virtual world, regardless of our physical locations.	4.44	0.55
Agency	**4.35**	**0.65**
I feel like I have control over my actions in the virtual world.	4.51	0.41
I feel like my choices and actions have a significant impact on the virtual world.	3.95	0.85
I feel a sense of ownership over my virtual actions and decisions.	4.46	0.50
I feel like I have the freedom to make choices and act in the virtual world as I wish.	4.37	0.49
Immersion	**4.13**	**0.78**
The virtual world feels like a real, tangible place to me.	4.55	0.43
I forget about my surroundings and lose track of time while immersed in the virtual world.	3.97	0.84
I feel emotionally connected to the virtual world and the experiences I have within it.	3.44	1.06
The virtual world feels like it has its own unique environment, separate from the real world.	4.58	0.41
Social Relationship	**3.91**	**1.02**
I feel that the connections I make in the virtual world are meaningful.	3.33	1.09
The virtual world allows me to form connections with others that I would not have in real life.	3.37	1.11
The interactions I have in the virtual world are as important to me as those I have in real life.	4.49	0.43
I feel a sense of community within the virtual world and among its users.	4.44	0.50

computer environment is typically represented in the form of a digital avatar [34]. Following our findings, it is crucial to ensure that the avatar design and customization options are extensive. This functionality allows metaverse inhabitants to form a digital representation that closely resembles their physical self or desired persona. Virtual items such as clothes and accessories as well as behaviors and animations are consequently essential in the metaverse. These realizations strengthen the necessity for establishing authenticity and a sense of realism both in terms of digital avatars and the virtual environment [17, 32]. Likewise, it underscores the significance of mirror worlds as a type of metaverse since it bridges the gap between the physical and digital worlds.

Another significant finding emphasized by our study is the necessity for creating many opportunities that allow students to create shared experiences with fellow metaverse users. Having shared activities promotes social interaction within virtual environments which can lead to stronger social relationships [36, 38]. As these digital connections play a critical role in virtual worlds, educators and designers need to prioritize the development of features and tools that enable students to connect and collaborate effectively. By fostering a sense of community within the metaverse, students are more likely to feel engaged and invested in their metaverse experiences, which can translate into greater motivation and academic success. Additionally, creating opportunities for cross-cultural interactions can help to broaden students' perspectives and promote greater empathy and understanding across diverse groups. Therefore, it

is crucial to actively facilitate and encourage social interactions within the metaverse to support students' overall well-being [37].

5 CONCLUSIONS

In this study, we created a virtual world to simulate a real-life school environment and explore students' perceptions toward their metaverse experiences. Our quantitative analysis reveals that students feel highly present and engaged in the virtual environment, with a sense of agency and immersion. It also underscores the importance of enhancing embodiment and copresence to create more effective virtual world experiences, as well as creating opportunities for shared experiences and social interactions within the metaverse. Meanwhile, our qualitative analysis uncovers several underlying subthemes concerning the constructs we employed based on the Embodied Social Presence Theory. These subthemes shed light on the importance of avatar customization, identity exploration, virtual items, communication, entertainment, autonomy, freedom of expression, realism, challenges, shared experiences, and a sense of belonging within the metaverse. Overall, our study provides valuable insights into the potential of metaverse technology in the educational context, and how it can be harnessed to create more effective and engaging academic experiences for students. As the use of metaverse technology continues to grow in education and beyond, our findings offer useful guidance for designers, educators, and policymakers to ensure that metaverse experiences are optimized for student success.

Table 3: Subthemes and Sample Statements from the Qualitative Feedback

Themes	Subthemes and Sample Statements
Embodiment	**Avatar Customization** • I love that I can customize my avatar, but the current options are limited. • More options for different body types and shapes should be added. • With limited options, I feel like everyone's avatar ends up looking the same. **Identity Exploration** • There should be options to create characters aside from male or female. • I think it is a great idea for people to switch avatars once in a while. • I love that students can express their personalities in the virtual world. **Virtual Items** • I recommend adding more outfits aside from uniforms to the marketplace. • Although it is just a trial, some products are not yet properly priced. • I feel like I have a virtual wardrobe when I purchased all tech shirts.
Copresence	**Communication** • The lack of voice communication makes it difficult to talk to others. • I appreciate the chat feature but there should be voice functionality. • There should be a private chat so other students won't see my messages. **Entertainment** • I liked the scavenger hunt, but it was difficult to search the whole building. • The developers should add more entertaining activities to the virtual world. • There should be many minigames that we can play with other students.
Agency	**Autonomy** • It is relaxing to simply move around in the virtual world with no quests like in a game. • Unlike in my real life, I feel like I am in control of my 'virtual life'. **Freedom of Expression** • I appreciate the fact that we can do and say everything with no censorship. • For me, it is more difficult to express myself in real life than in the application.
Immersion	**Realism** • It's amazing how the developers created an exact replica of our school. • The attention to detail was impressive, especially in the lobby of FEU Tech. • Lighting and shadows should be improved to create a sense of depth. **Challenges** • Since there is no character progression, there should be more challenging games. • More multiplayer challenges should be added for teamwork purposes. • The virtual world should challenge our mental skills like in the classroom.
Social Relationship	**Shared Experiences** • I never thought it would be enjoyable to visit other FEU campuses with my friends. • Leaderboards should be added so I can compete with other students. • Connecting with students from other campuses is one of my favorite things to do. **Sense of Belonging** • I am an introvert and I appreciate the feeling of connecting with other students virtually. • I suggest that there should be clubs and organizations to cater to different interests. • I appreciate that I can connect with like-minded students and build friendships.

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