Social Relationship Development in the Metaverse: The Roles of Embodiment, Immersion, and the Moderating Effect of Copresence

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***Abstract*—Social relationships are important to human well-being and interaction. Recently, there has been growing interest in how they are formed in various digital media, including social media and video games. Amid the rise of digital engagement, the metaverse has emerged as an essential virtual environment for social interaction. Unfortunately, there is limited understanding of how social relationships are developed and maintained within the metaverse. In this study, we explored the dynamics of social relationship development in a metaverse world. Using a one-shot case study, we assessed the roles of immersion and embodiment, as well as the moderating effect of copresence, in building social relationships through multiple regression analysis. Our findings show that with higher levels of immersion and embodiment, the formation of social relationships in the metaverse is significantly improved. Copresence further intensifies these effects, which is indicative of its crucial role in virtual social interactions. These results indicate that enhancing the immersion, embodiment, and copresence elements in metaverse environments can encourage stronger social bonds among users. Overall, this study advances our understanding of online social relationship formation in the metaverse environments and its design and development.**

Keywords—Metaverse, Virtual World, Social Relationship, Immersion, Copresence, Embodiment, Digital Interaction

I. Introduction

Social relationships constitute the interactions and bonds between two or more individuals established through mutual interests, communication, and shared experiences [1-3]. These relationships can vary in depth and significance, from casual acquaintances to close familial or intimate connections. Prior research has demonstrated a robust connection between the quality of social relationships and various health metrics [4]. These relationships are crucial for developing and maintaining health throughout an individual's life course [5, 6]. They serve multiple functions, including promoting healthful behaviors, strengthening community ties, reinforcing personal identity and security, providing emotional and practical support, and enhancing overall health. In recent years, there has been an increasing emphasis on fostering social relationships through digital platforms, utilizing various media such as video games [3] and social media [7]. This shift towards digital engagement sets the stage for exploring more innovative environments like the metaverse, where new dimensions of social interaction and connection are emerging [8, 9]. Such a development warrants further study of its potential for social connectivity.

The metaverse is a collective virtual shared space created by converging virtually enhanced physical and digital reality [10]. This virtual space continuously operates online, offering interactive experiences via 3D avatars. The metaverse concept was first introduced in Neal Stephenson's 1992 novel '*Snow Crash*,' which depicted a virtual environment where humans could interact with each other and digital entities. Now, it has evolved into a platform that advances social realities in ways previously confined to the imagination [11]. In the metaverse, users can engage in various activities (from social gatherings to collaborative work) that extend the boundaries of traditional social relationships. Despite its potential to transform social connections through immersive experiences, there remains a gap in our understanding of how relationships are promoted in the metaverse. This gap emphasizes the need for further study on how virtual interactions in the metaverse influence social relationship formation. Accordingly, this study aims to assess the mechanisms of social relationship development within the metaverse context. By identifying the underlying factors that foster social bonds in the metaverse, this study will contribute to the broader discourse on technology's role in shaping future social structures. As the digital and physical worlds continue to converge, this study will offer timely knowledge to ensure that virtual environments foster meaningful human relations.

II. Theoretical Framework

Serving as the guiding theoretical framework of this study, the Embodied Social Presence Theory (ESPT) posits that the sense of being physically present with others in a shared space can be simulated through digital means [12]. ESPT argues that the simulation of physical presence through avatars enhances the perceived intimacy and authenticity of interactions. These tenets have been investigated within the context of metaverse environments in existing literature [13]. A notable example is the MILES Virtual World [14], which is the metaverse world utilized in this study to investigate these dynamics. As noted in the literature, ESPT is particularly relevant to examining social dynamics in the metaverse, where users interact through digital proxies that represent them in rich, three-dimensional worlds. It also emphasizes how these environments can mimic the sensory feedback and social cues universally observed in physical interactions. Consequently, ESPT is an appropriate theoretical framework for this study as it directly addresses the core elements of how digital environments like the metaverse can replicate and even enhance social interactions.

Building on the ESPT framework, the immersive nature of the metaverse is a key area of focus. Immersion in this context is the intensity of engagement and sensory envelopment users experience [15]. This extreme level of engagement is critical for fostering genuine interactions and emotional connections, laying the foundation for building deeper social relationships. ESPT particularly highlights the role of embodiment—or how users are represented and perceive themselves and others via avatars [16]. A richly detailed and responsive avatar enhances the realism of interactions, rendering social exchanges more meaningful and personal. This heightened sense of presence and authenticity through effective embodiment can strengthen social bonds among users. Meanwhile, the perception of being in the same virtual space with others can likewise intensify the impact of embodiment and immersion. Copresence amplifies the sense of physical presence among users [13], contributing to a stronger sense of community and connectedness within the metaverse world. This shared spatial experience enhances the feeling of togetherness and is critical for facilitating richer, more impactful social interactions. The synergy between these components can create a robust framework for understanding how virtual environments can replicate and enhance the social dynamics naturally observed in the physical world (Figure 1). This interaction is central to the proposed hypotheses:

H1: Embodiment will have a positive significant impact on building social relationships in the metaverse.

H2: Immersion will have a positive significant impact on building social relationships in the metaverse.

H3: Copresence will moderate the relationship between embodiment and social relationships.

H4: Copresence will moderate the relationship between immersion and social relationships.

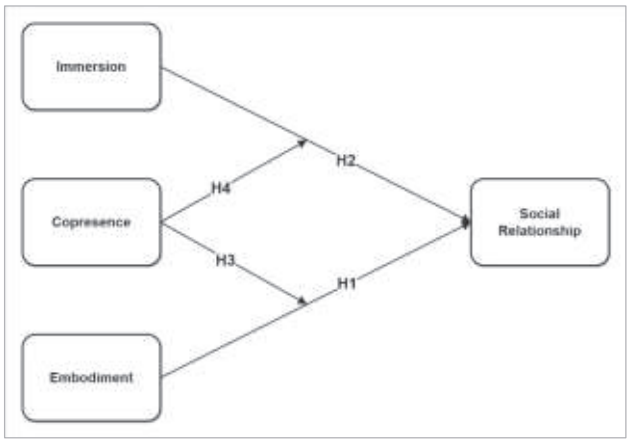

Fig. 1. Theoretical Framework of the Study

III. Methodology

A. Research Design

This study employs a one-shot case study research design, a specific type of non-experimental research method in which a single unit is observed or analyzed after an intervention has occurred without the use of a pretest or a control group. This design is particularly useful when the objective is to acquire a contextual analysis of a unique or novel phenomenon within its real-life context. It is appropriate for exploratory purposes, especially when the constraints of time or resources preclude more extensive experimental designs. It was selected for this research due to the distinctive characteristics of the metaverse as an emergent technological application. By analyzing data post-implementation, this design provides insights into the immediate effects of the metaverse environment, particularly how its features of embodiment, immersion, and copresence influence social interactions among its inhabitants.

Fig. 2. Summer Edition Promotional Poster of the MILES Virtual World

B. Metaverse Application

The metaverse application used to conduct this study was MILES Virtual World—a digital school environment for the FEU Group of Schools. It operates under the principles of the ESPT, allowing users to interact socially in the virtual world through customizable avatars and engage in various academic and extracurricular activities comparable to those in a physical school setting [11]. MILES Virtual World showcases a mirror world architecture by reconstructing digital versions of three physical campuses. For this study, we expanded the virtual world by introducing an additional "*Summer Camp*" map (see Figure 2) set on a beach inspired by Philippine landscapes. It is designed to augment the interactive and social elements of the platform by offering a unique setting that differs from the academic focus of the main campuses. To enrich the Summer Camp experience, we introduced new social activities to foster user interaction and camaraderie. These include a multiplayer racing game called "*Summer Slide*," water gun battles in "*Splash Wars*," fishing, and more. Each activity encourages cooperative and competitive play to provide diverse ways to engage with each other and the virtual environment, further enhancing the social dynamics explored in this study.

C. Questionnaire and Participants

This study collected data using a structured questionnaire, previously utilized in our metaverse research [14] and adapted for the current study to emphasize social contexts. It is divided into two sections: demographic and social experience. For the demographic section, it collects basic data from respondents such as age, gender, level, and program. The second section is focused on the social experience specifically tailored to assess the social dynamics at the newly introduced Summer Camp setting. It consists of 20 items, divided equally among four key constructs of the study: immersion, copresence, embodiment, and social relationship. This questionnaire was given to all the participants who completed the game. In terms of participants, the study involved multiple teams composed of players who interacted within the Summer Camp environment. A total of 18 teams participated, each consisting of five players ($n = 90$). The groupings were strategically diverse (e.g., heterogenous teams, homogenous class teams, homogenous program teams, and others) to ensure that initial differences do not confound comparative analyses of post-game social experience ratings.

IV. Results

Before testing our hypotheses, we conducted a one-way ANOVA test to evaluate if there were any differences in the perceptions of social relationships across the various groups. The test analysis yielded an *F*-value of 0.148 and a *p*-value of 0.636, indicating that the differences in score evaluations were not statistically significant ($p > 0.05$). This finding suggests that perceptions of social relationships were consistent across groups, regardless of their composition. We also evaluated the reliability of the scales using Cronbach's Alpha. The overall alpha score was 0.82, indicating high reliability and consistent measurement across the combined constructs. Individually, the alpha scores were as follows: 0.85 for immersion, 0.78 for copresence, 0.80 for embodiment, and 0.81 for social relationship. These scores corroborate the internal consistency among the items within each construct, affirming that the scales are robust and effectively capture the nuances of each dimension of social interaction within the metaverse.

TABLE I. Regression Analysis Results for H1 and H2

Predictor Variable	*β*	*t*-value	*p*-value
Immersion	0.251	2.947	.003
Embodiment	0.389	3.569	.001

β = Standardized coefficient; $F = 21.543$; $p = 0.000$; $R^2 = 0.563$; Adjusted $R^2 = 0.523$.

We conducted multiple regression analyses to evaluate *H1* and H2, with the findings presented in Table 1. The analyses revealed that the overall model was statistically significant ($p < 0.05$), accounting for 52% of the variance in terms of social relationship outcomes. The regression coefficients indicated positive relationships for both embodiment ($\beta = 0.251$) and immersion ($\beta = 0.389$) with respect to their involvement in the metaverse. Both coefficients were found to be statistically significant, aligning with the anticipated positive direction. Consequently, *H1* and *H2* were supported by the data.

TABLE II. Regression Analysis Results for H3

Predictor Variable	*β*	*t*-value	*p*-value
Embodiment	0.317	3.915	.001
Copresence	0.392	4.662	.001
Embodiment x Copresence	0.379	4.124	.000

β = Standardized coefficient; $F = 15.526$; $p = 0.000$; $R^2 = 0.597$; Adjusted $R^2 = 0.551$.

For *H3*, the multiple regression model was structured to assess the moderation effect of copresence on the relationship between embodiment and social relationship development within the MILES Virtual World. Here, "*embodiment*" serves as the independent variable, "*copresence*" as the moderator, and the interaction between these two variables—denoted as "*embodiment x copresence*"—acts as the interaction term. The outcome variable is the strength of social relationships, which includes the measure of how supportive these relationships are perceived by the participants. As shown in Table 2, the results revealed that the interaction term significantly influenced the strength of social relationships, as indicated by a positive and statistically significant coefficient ($\beta = 0.379$, $p = .000$). This finding confirms that copresence effectively moderates the relationship between embodiment and the development of social relationships. Furthermore, the analysis highlighted that the direct effect of the moderator variable on the strength of social relationships was strong. The coefficient for copresence alone ($\beta = 0.392$, $p = .001$) not only demonstrated statistical significance but also showed a substantial positive effect. This finding implies that higher levels of copresence independently and significantly contribute to the strength and supportiveness of social relationship development within the metaverse.

TABLE III. Regression Analysis Results for H4

Predictor Variable	*β*	*t*-value	*p*-value
Immersion	0.325	3.826	.003
Copresence	0.412	4.358	.003
Immersion x Copresence	0.395	4.019	.001

β = Standardized coefficient; $F = 18.568$; $p = 0.000$; $R^2 = 0.529$; Adjusted $R^2 = 0.493$

For *H4*, we followed a similar procedure to examine the moderation effect of copresence on the relationship between immersion and the development of social relationships within the metaverse world. In this model, "*immersion*" serves as the independent variable, "*copresence*" again functions as the moderator, and the product—"*immersion x copresence*"—forms the interaction term. The outcome variable, as with *H3*, is the strength of social relationships, denoting the perceived supportiveness of these relationships by the metaverse users. Table 3 establishes that the interaction term had a significant impact on the strength of social relationships, indicated by a positive and statistically significant coefficient ($\beta = 0.395$, $p = .001$). Similar to *H3*, this finding indicates that the moderation effect of copresence enhances the influence of immersion on social relationship development, supporting *H4*. It shows that higher levels of copresence can indeed amplify the effects of immersion, leading to the formation of stronger social bonds. This finding validates the hypothesis that copresence plays a crucial role in magnifying the positive effects of immersive experiences on social interactions within the metaverse. It was also found that the direct effect of the moderator variable on the outcome was significant and robust. The coefficient for copresence alone in this model ($\beta = 0.412$, $p = .003$) confirmed its significant and positive influence on the strength of social relationships independently of immersion. This result proves that copresence not only directly influences social relationship development but also has more robust mediating effects on the relationship between the other predictor variables.

V. Discussion and Conclusion

Social relationship development has conventionally been viewed as a process occurring within physical interactions [1], where face-to-face engagement and tangible situations play essential roles in promoting bonds and understanding among individuals [2]. As highlighted by previous studies [4, 5], this aspect of human interaction is foundational to both social and personal well-being. Hence, understanding the dynamics and implications of social relationships remains a critical area of research, particularly as these interactions increasingly occur in digital contexts [3, 7]. With virtual platforms progressively evolving and becoming more immersive and interactive [17], it is important to explore how these new modalities compare to or enhance traditional social interaction methods. This gap is particularly pertinent considering the increasing prevalence of virtual environments that simulate real-world settings, such as the metaverse [8, 10, 15], which offer unique opportunities for socialization beyond physical boundaries. In this study, we addressed this gap by investigating the roles of embodiment, immersion, and copresence in the metaverse. This is essential for informing the design of future digital platforms that aim to enhance social interaction in an increasingly digital society.

Our results indicate that both embodiment and immersion significantly positively affect social relationship development within virtual environments. Embodiment, facilitated through detailed and responsive avatars, enables users to project their identity and interpret social cues more effectively [8], which likewise enhances interpersonal interactions [18]. This finding is consistent with prior works that highlight the importance of avatar quality in increasing social presence and fostering trust among users on digital platforms [11, 19]. Interpreting these findings through the lens of ESPT, it is clear that the realistic portrayal of oneself and others in a metaverse can significantly boost the perceived intimacy and authenticity of interactions. Similarly, immersion was discovered to play a crucial role in engaging users more deeply with the metaverse environment. Given the limited literature specifically addressing the direct impact of immersion on social relationship formation within the metaverse, our study contributes to filling this scarcity by demonstrating that higher levels of sensory and psychological engagement augment the quality of social interactions. This finding indicates that environments offering deeper immersive experiences can cultivate more meaningful and emotionally impactful social connections [20]. Supporting this result is the Media Richness Theory, which indicates that environments that provide a richer, more comprehensive sensory experience are better suited to handle complex social exchanges [8].

Another notable finding of the study is the effective role of copresence as a mediator between embodiment, immersion, and social relationship development. Our findings extend the ESPT by demonstrating that copresence amplifies the impacts of embodiment and enriches the immersive experience. When participants perceive a higher level of copresence, the effects of both embodiment and immersion on the quality of social relationships are remarkably enhanced. This synergistic effect suggests that copresence is a critical bridge that magnifies how both the physical representation (*embodiment*) and the depth of sensory engagement (*immersion*) impact social interaction quality. Moreover, the Social Information Processing Theory, which posits that people can develop relationships online that are as close as those formed face-to-face [21], provided the communication channels offer sufficient cues over time, also aligns with our results. Copresence boosts these cues, making interactions feel more immediate and real. This amalgamated theoretical approach highlights the critical role of designing metaverse environments that simulate both physical presence and immersive experiences to optimize social dynamics.

As metaverse technologies continue to evolve, harnessing these elements can transform digital interactions. Bridging the gap between physical and virtual worlds, these advancements can pave the way for a future where meaningful relationships can thrive, irrespective of physical boundaries. The potential for human connection in the metaverse is both profound and promising, which highlights the need for more future research.

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