Research Article

Yoga in the Metaverse: Possibilities and Limitations

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ABSTRACT

This study aims to assess the integration of yoga within the South Korean metaverse, determining its viability and potential impact on digital wellness practices. The study employed a mixed-methods approach, analyzing metaverse content relationships *via* the Pearson correlation coefficient and conducting focus group interviews. Key search terms tracked over a decade informed the quantitative analysis, while the qualitative aspect involved discussions with yoga instructors and trainees. The interview data was processed using phenomenological methods to extract key themes and perceptions. This combination of big data analytics and phenomenology provided insights into the current engagement with yoga in the metaverse and identified barriers to its adoption. The quantitative analysis revealed that while gaming and education had moderate to strong correlations, yoga had an insignificant relationship, suggesting a lack of integration into virtual spaces. Qualitatively, both instructors and trainees acknowledged the metaverse's potential to enhance yoga's inclusivity and appeal through interactive and gamified environments. However, they also highlighted significant challenges, such as technological barriers, cost, and community building, and maintaining the authenticity of yoga practice. These factors impede the widespread acceptance and integration of yoga within the metaverse. In conclusion, to solidify yoga's presence in the Korean metaverse, strategic enhancements addressing accessibility, community dynamics, cost, and technological ease-of-use are necessary to harness the metaverse's full potential for wellness.

Keywords: Metaverse; Yoga; BIGKinds; Focus group interview; Possibilities; Limitation

INTRODUCTION

The metaverse, an immersive virtual ecosystem, can be defined as a hybrid environment that blends digital and physical universes [1]. Metaverse platforms have emerged as prominent venues for collaboration within virtual spaces [2]. The COVID-19 pandemic emphasized the importance of non-contact activities and remote platforms and highlighted the significance of the metaverse [3]. As traditional face-to-face interactions became limited, the metaverse became a key space for virtual engagement, offering new possibilities for connection and collaboration in an increasingly digital world. Metaverse technology, initially popular in gaming [1], has evolved to encompass various content areas, including performances, exhibitions, education, and sports [4]. Additionally, the technology allows for virtual storefronts where consumers can experience shopping as they would in a physical store, and it enables artists to stage performances that audiences can attend from anywhere in the world, breaking down geographical barriers and expanding reach [5]. In addition, it is forecasted that by 2026,

a quarter of the population will dedicate a minimum of one hour daily to activities such as working, shopping, learning, socializing, and entertainment within the metaverse [6]. Meanwhile, yoga is an exercise that benefits both the mind and body, offering a holistic approach to wellness that enhances mental clarity, emotional balance, and physical health [7]. Commonly utilized for its health benefits, the key components of yoga include asanas (physical postures), pranayama (regulated breathing), and meditation. Thus, yoga practice offers psychological benefits such as reducing stress, aiding in overcoming anxiety and depression, and improving sleep quality. Within the realm of asanas, yoga resembles more of a physical exercise, leading to the perception of yoga as another kind of workout [8]. Yoga courses are often available online through live streams and pre-recorded videos, allowing viewers to follow along and practice at their convenience [9]. Furthermore, increased accessibility, convenience, and personalized practice are offered by remote virtual yoga, with participants being able to engage in yoga from any location, have sessions tailored to their needs, and integrate yoga into their daily routine with greater

ease [10]. The need for yoga in the metaverse may stem from the increasing demand for holistic wellness practices within digital environments. As people spend more time in virtual settings [11], the importance of maintaining physical health and mental well-being becomes paramount. Yoga in the metaverse can offer a unique solution by providing an accessible, inclusive, and versatile platform for practicing mindfulness and physical exercises without geographic constraints [12]. Additionally, the immersive nature of the metaverse may enhance the yoga experience [13], allowing practitioners to engage in sessions set in calming, virtual landscapes that may enhance relaxation and focus. The flow experience is pivotal for achieving optimal performance and learning [14-16]. With its immersive and customizable environments, the metaverse offers a unique platform that can amplify this flow state [17]. Therefore, the metaverse may facilitate a deeper connection between movement, breath, and mindfulness by providing virtual spaces where practitioners can fully engage without distractions.

Meanwhile, there is a need to examine social interest in new platforms, such as yoga in the metaverse, and trainees' perceptions of its acceptance. Rogers EM [18], suggested the concept of diffusion of innovations, which explores how new ideas, behaviors, technologies, or goods spread gradually through a population [18]. Rogers EM also identifies key factors influencing adoption, including socioeconomic characteristics, inner innovativeness, and perceived characteristics of innovation [19]. These perceived traits, like relative advantage, compatibility, complexity, trialability, and observability, shape adoption rates. For instance, innovations perceived as superior and compatible tend to spread faster, while complexity acts as a barrier. Trialability reduces perceived risk, and observability enhances adoption. As Rogers EM [19], Five Factors model provides a framework for understanding the dynamics of innovation adoption, this study examined yoga in the metaverse regarding relative advantage, compatibility, complexity, trialability, and observability. Also, to foster the activation of yoga in the metaverse, research into societal interest and the perceptions of both yoga instructors and trainees is essential. However, there has been scant research conducted in this area. Therefore, this study examined the extent of the Korean media's interest in yoga in the metaverse and the perceptions of yoga instructors and trainees towards yoga in the metaverse. This study aims to assess the integration of yoga within the South Korean metaverse, determining its viability and potential impact on digital wellness practices.

MATERIALS AND METHODS

Metaverse

The metaverse can be defined as a virtual environment that blends physical and digital universes [1]. Metaverse technology is a complex system composed of various interconnected elements that create immersive digital universes where users can interact, work, play, and participate in a wide range of activities similar to the real world. At its core, it integrates advanced technologies such as Virtual Reality (VR), which offers fully immersive experiences by transporting users into entirely digital environments, and Augmented Reality (AR), which overlays digital information onto the physical world, enhancing real-world interactions with

virtual elements [20]. VR is a technology that creates a completely immersive digital environment, isolating the user from the physical world [21]. Using headsets and sometimes additional equipment, users can experience and interact with a 3D virtual world [22]. On the other hand, AR blends digital elements with the real world, overlaying computer-generated images, sounds, or other data onto the natural environment [23]. Recently, the metaverse has garnered significant attention, with applications expanding through mobile augmented reality [24]. However, metaverse technology currently faces several significant challenges. The level of realism and immersion is a major obstacle to revitalizing the metaverse industry. While VR and AR technologies have made significant strides, achieving a truly lifelike experience that can fool the senses remains a work in progress. This includes not only visual and auditory immersion, but also tactile feedback and movement within virtual spaces, which are areas still under development. Flow is defined as a state of complete immersion in an activity, characterized by a sense of fluidity between one's body and the environment and a complete absorption that results in the loss of temporal awareness [14]. In the context of the metaverse, the immersive quality of VR can catalyze the experience of flow. When practicing yoga within a virtual space, the distractions of the physical world are minimized, potentially enabling a deeper focus and connection with the practice. The VR environment can be tailored to individual preferences, such as serene landscapes or tailored ambient sounds, which can facilitate the flow state [16]. Moreover, real-time biofeedback provided by wearable technology can enhance this experience by aligning the trainee's physical responses with the virtual environment, thus supporting the integration of flow in the practice of metaverse yoga.

Yoga

Yoga refers to a group of mental, spiritual and physical practices or disciplines that originated in ancient India [25]. Yoga has gained popularity recently, with many practitioners practicing poses such as Hatha yoga and Vinyasa yoga [26]. Hatha yoga is a foundational style that emphasizes physical postures (asanas), breath control (pranayama), and meditation. It aims to prepare the body for deeper spiritual practices by improving strength, flexibility, and mental concentration. Vinyasa yoga, known as "flow" yoga, combines dynamic movements with synchronized breathing for a vigorous, athletic practice, enhancing cardiovascular health, flexibility, and strength. Thus, Vinyasa yoga can unify breath and movement for a smooth flow [27]. Yoga can be conducted in various places and in diverse ways [28]. For example, yoga studios can provide a professional community space for tailored guidance in small classes or private lessons, deepening the yoga practice [29]. Home yoga practice using videos offers flexibility, allowing individuals to schedule sessions conveniently and access online resources for a private and adaptable experience [30]. Health clubs and fitness centers integrate yoga into their fitness programs, creating a social setting for a varied exercise routine [31]. Outdoor yoga connects practitioners with nature, offering a rejuvenating alternative to indoor practice with the added benefits of fresh air and natural ambiance [32]. Furthermore, online platforms and applications enable yoga enthusiasts to practice anywhere, anytime, catering to the demands of a busy lifestyle by removing constraints related to scheduling and location,

and are thus gaining popularity due to their ease and flexibility [9,33]. For instance, VR yoga has been shown to improve physical function and reduce pain in middle-aged women with lower back pain, as well as enhance functionality and alleviate trigger point discomfort in chronic lower back pain patients, suggesting VR yoga as an effective treatment modality [34,35]. Therefore, this study examined the possibilities and limitations of yoga in the metaverse for Hatha yoga and Vinyasa yoga.

Diffusion of innovations theory

Diffusion of innovations is a theory by Rogers EM [18], that shows how new ideas, behaviors, technologies, or goods can spread through a population gradually, rather than all at once [36]. The innovation paradigm includes various theories, such as the theory of diffusion of innovation, the theory of reasoned action, and the technology acceptance model [37].

The theory of diffusion of innovation, systematically organized and presented by Rogers EM [38], based on the achievements in various social science fields, explains the entire process of innovation adoption. Rogers EM defines innovation as an idea, practice, or object that is perceived as new by an individual or other unit of adoption, and in the theory of diffusion of innovation, the factors influencing the adoption of such innovations are categorized into socioeconomic characteristics, inner innovativeness, and perceived characteristics of innovation [19].

In research on the adoption of innovative technologies or products, the perceived characteristics of innovation are further classified into relative advantage, compatibility, complexity, trialability, and observability [19]. Table 1 presents the five factors of Rogers' theory, and the details are as follows: Relative advantage of an innovative product or service compared to existing alternatives drives its adoption rate among consumers. It is determined by customers perceiving it as superior in various aspects, such as features, price, availability, or communication. Compatibility refers to how closely a product or service aligns with consumers' needs, values, norms, and culture. Higher compatibility leads to quicker adoption, while lower compatibility results in slower adoption. Complexity plays a crucial role in the diffusion of innovative products. When products are easy to understand, purchase, and use, they tend to diffuse more quickly. Conversely, technological complexity acts as a barrier to adoption, as consumers may fear the difficulty of purchasing and using the product. Thus, complexity serves as a barrier to adoption, with simpler, easier-to-understand products being more readily accepted.

Trialability refers to how easily consumers can test a product or service, which directly impacts its acceptance rate. Also, trialability encourages easier diffusion of products or services. Observability refers to the ease with which the product is observed. With an innovative product or service, observability refers to the degree to which a product or service's benefits can be observed, imagined, and perceived by a potential consumer. The extent to which the benefits of an innovation are visible to potential adopters also plays a crucial role in the diffusion process [39,40].

As Rogers EM[19], has shown that these perceived characteristics of innovation impact the adoption process significantly, with relative advantage, compatibility, and complexity having relatively higher explanatory power compared to trialability and observability, this study also examined society and the public's perception of yoga in the metaverse using five factors of Rogers' theory (Table 1).

BIGKinds

BIGKinds refers to a big data research solution offered by the Korea Press Foundation [41]. BIGKinds aids in analyzing a large-scale news database to identify current issues and trends receiving attention in Korean society [42]. BIGKinds can present search term frequency, Pearson correlation coefficients, and trend analysis of search terms [43].

For this study, key search terms such as "metaverse and game", "metaverse and concert", "metaverse and exhibition", "metaverse and education", "metaverse and exercise" and "metaverse and yoga" were used to examine changes in search frequency and correlation between two variables included in search terms. The Pearson correlation coefficient is a statistical measure of the strength of a linear relationship between two variables, indicating that values of the coefficient range from -1 to +1, with different ranges signifying varying degrees of correlation [44].

Focus group interview

A focus group interview is a qualitative research method involving a small group of participants who share their opinions, perceptions, and experiences on a specific topic or product [45].

Participants: Led by a skilled moderator, the discussion encourages open dialogue and idea exchange, providing valuable insights into participants' preferences, attitudes, and behaviors. Researchers gather in-depth qualitative data through interactive group dynamics to inform decision-making, product development, marketing strategies, and more. Focus group interviews offer a dynamic platform for exploring diverse perspectives, uncovering underlying motivations, and understanding the complexities of participant's behavior within a controlled setting [46].

This study conducted focus group interviews with 10 participants, including 5 yoga instructors and 5 trainees, on the topic of yoga in the metaverse. The demographic characteristics of the participants are as shown in Table 2. Out of 10 participants, nine subjects are female, and one is male, with ages ranging from 23 to 37. They primarily practice Hatha or Vinyasa yoga, with experience ranging from 2 to 8 years (Table 2).

Data collection: This study collected opinions on the possibilities and limitations from participants who have had experiences or have shown interest in yoga in the metaverse, as depicted in Figure 1. Based on the information provided, the focus group interviews were conducted using the Zoom online video conferencing platform with two groups consisting of 5 yoga instructors and 5 trainees. Participants volunteered for the interviews and provided informed consent.

The interviews took place in December 2023 and January 2024, totalling two sessions. The researchers, guided by Rogers EM [19], Diffusion of Innovation theory, asked participants about the possibilities and limitations of yoga in the metaverse within our

Table 1: Five factors of Rogers's theory.

Factors	Description
Relative advantage	Relative advantage is determined by customers perceiving the product or service as superior in various aspects, such as features, price, availability, or communication.
Compatibility	Compatibility refers to how closely a product or service aligns with consumer's needs, values, norms, and culture.
Complexity	Complexity serves as a barrier to adoption, with simpler, easier-to-understand products being more readily accepted.
Triablility	Trialability refers to how easily consumers can test a product or service, which impacts its acceptance rate directly.
Observability	Observability refers to the ease with which the product or service is observed.

Table 2: Characteristics of participants.

Category	Gender	Age	Occupation	Experience
Participant 1	Female	33	Instructor	5 years
Participant 2	Female	35	Instructor	6 years
Participant 3	Female	28	Instructor	4 years
Participant 4	Female	37	Instructor	8 years
Participant 5	Female	32	Instructor	3 years
Participant 6	Female	36	Service staff	4 years
Participant 7	Female	32	Teacher	2 years
Participant 8	Female	35	Marketer	3 years
Participant 9	Female	23	Student (University)	2 years
Participant 10	Male	30	Student (Undergraduate)	2 years

Figure 1: A woman wearing a headset and experiencing immersive yoga in the metaverse.

society, encouraging them to share their opinions freely [19]. All discussions were recorded and transcribed.

Data analysis: Search term analysis related to yoga in the metaverse was conducted using the previously mentioned BIGKinds. The analysis of participants' statements about yoga in the metaverse through focus group interviews was conducted using the phenomenological research method suggested by Colaizzi PF [47], for a thorough understanding. Descriptive phenomenology comprises four steps: Bracketing, intuiting, analyzing, and describing [47]. Bracketing involves setting aside preconceived notions about the phenomena. Intuiting entails remaining open to participant's interpretations. Researchers then analyze the data by extracting significant statements and categorizing them to discern essential meanings. Finally, in the describing phase, researchers define and comprehend the phenomenon. These steps allow for a comprehensive exploration of participants' experiences, ensuring an accurate portrayal of their perspectives [48].

RESULTS

BIGKinds

This study quantifies the metaverse's relationship with various content terms *via* the Pearson correlation coefficient. Coefficients range from weak (+0.1 to +0.3), and moderate (+0.3 to +0.7), to strong (+0.7 to +1.0) positive linear relationships. Figure 2 shows the frequency of searches for the metaverse and each content-

related term over the past ten years (2014-2023). "Metaverse, Game" shows a clear relationship, while "Metaverse, Concert" and "Metaverse, Sports" indicate weaker ties. "Metaverse, Education" and "Metaverse, Exhibition" reveal moderate associations. In contrast, "Metaverse, Yoga" has an insignificant relationship. (Figure 2) charts these search frequencies over a decade. The specific results are as follows. For the term "Metaverse, Game," a coefficient of 0.5418 emerges from 582,440 news search results, placing it within the range of a clear positive linear relationship. In the case of "Metaverse, Concert," with 646,239 news search results, the Pearson correlation coefficient of 0.2841 suggests a weak positive linear relationship. In the case of "Metaverse, Exhibition," with 460,001 news search results, the Pearson correlation coefficient of 0.4244 indicates a moderately positive linear relationship. In case of "Metaverse, Education", with 1,470,356 news search results, the Pearson correlation coefficient of 0.4444 indicates a moderately positive linear relationship. When examining "Metaverse, Sports," the coefficient of 0.3009 from 528,604 news search results suggests a weak to moderate positive linear relationship, indicating an emerging link that may warrant further investigation as the metaverse continues to develop. Lastly, the term "Metaverse, Yoga", this yielded 70,025 news search results and a coefficient of -0.0571, falls back into the category of an almost negligible linear relationship. The findings indicate that in the Korean societal context, activities such as gaming, concerts, sports, and educational pursuits within the metaverse gain more social interest than yoga practice,
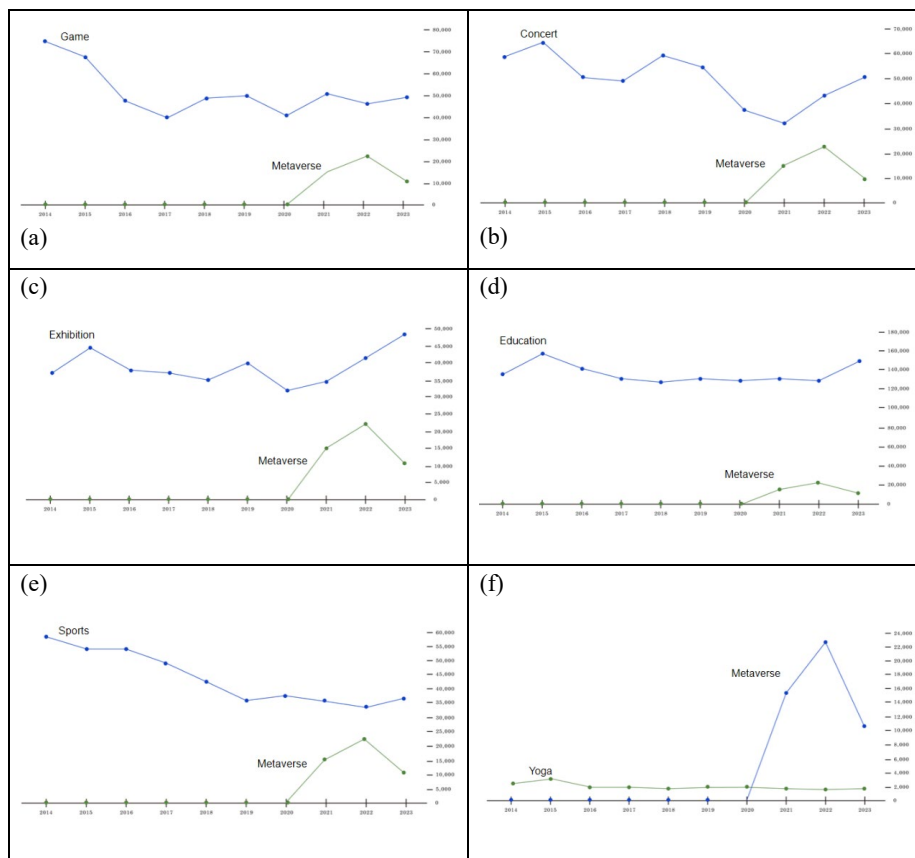

Figure 2: Search frequency of terms related to content within the metaverse in Korean media over the past decade (2014-2023). (A): Metaverse and game; (B): Metaverse and concert; (C): Metaverse and exhibition; (D): Metaverse and education; (E): Metaverse and sports; (F): Metaverse and yoga.

highlighting that yoga's assimilation into the virtual realm has yet to garner substantial public engagement. Consequently, this study examined the perceptions of yoga instructors and trainees towards yoga in the metaverse in the following section (Figure 2).

Results of the focus group interview

The results after the focus group interview basically involves:

Instructor's perception of the possibilities and limitations of yoga in the metaverse: Table 3 shows the 25 main statements from yoga instructors who participated in the focus group interview and the classification of formulated meaning, themes, and theme clusters accordingly.

Ultimately, yoga in the metaverse as perceived by yoga instructors was categorized into possibilities and limitations. Specifically, the possibilities due to relative advantage, compatibility, triability, and observability recognized by yoga instructor can be summarized as follows.

Yoga in the metaverse holds the potential to broaden participation significantly, welcoming a diverse range of trainees, including those with physical disabilities, by offering easy access and the option of anonymity. It fosters a more engaging learning environment that can blend with traditional classes and enhance motivation through gamification. Efforts to improve the quality and reliability of virtual platforms can further support this expansion. The metaverse's interactive features aid in delivering a unique experience, allowing for the exploration of various styles and teaching methods. It opens doors to creatively diversifying teaching techniques and provides an immersive experience by enabling trainees to customize their virtual surroundings, potentially transforming yoga practice and pedagogy.

Meanwhile, their perception of specific limitations due to triability and complexity is as follows. Yoga in the metaverse encounters several limitations, such as a learning curve that may deter newcomers unfamiliar with virtual environments. Access to the metaverse is not universal, presenting technological barriers and cost issues that could restrict participation. The financial stability of yoga classes may be uncertain in the metaverse, where revenue models are still being explored. Furthermore, fostering a sense of community can be challenging without the traditional, physical gathering spaces, and concerns about the protection of personal information are heightened in these digital domains. Additionally, the absence of physical presence and tactile contact may impede the complete immersion and experience of a yoga practice that traditionally relies on these elements (Table 3).

Table 3: Perceptions of a focus group of yoga instructors.

Significant statements	Formulated meaning	Themes	Theme clusters	Category
• Yoga in the metaverse could significantly enhance trainee engagement and focus. • The metaverse could open access to yoga, reaching those in remote areas. • Yoga in the metaverse could allow for more inclusive classes, accommodating people with physical disabilities. • The interactive features of the metaverse platform can create a more engaging learning environment. • The anonymity of the metaverse might make some trainees more comfortable trying yoga.	• Opportunities to expand participation from a variety of trainees increase. • Trainees with physical disabilities can also participate relatively easily. • Easy to participate through anonymity. • Creating a more engaging learning environment.	• Increased opportunities to expand participation in various ways • Creating a more engaging learning environment	• Possibilities due to relative advantage	
• Blending the metaverse with traditional yoga classes could offer flexibility for trainees with tight schedules. • Metaverse yoga sessions could incorporate gamification to increase motivation. • The success of yoga in the metaverse will heavily depend on the quality and reliability of the virtual platform used.	• Blending with traditional yoga classes can provide flexibility. • Motivation possible through gamification. • Improving the quality and reliability of virtual platforms.	• Compatibility with various types of classes will be an advantage of yoga in the metaverse	Possibilities • Possibilities due to compatibility	Possibilities
• Maintaining smaller class sizes, even in the metaverse, ensures personalized attention. • The interactive features of the metaverse platforms can create a more engaging learning environment.	• Yoga in the metaverse can expand yoga participation. • Interactive features will be helpful.	• Exposure to various educational opportunities and methods • Promoting yoga immersion	• Possibilities due to triability	
• Yoga in the metaverse can offer unique experiences, like practicing in exotic virtual locations. • Yoga in the metaverse could expose trainees to a variety of styles and instructors globally. • The metaverse offers an opportunity for yoga instructors to creatively expand their teaching methods. • Immersion in yoga could be profound, as the virtual environment can be tailored to enhance the meditative aspects of yoga practice. • The metaverse may favor well-known instructors, potentially sidelining less-recognized instructors.	• Providing a unique experience. • Being able to refer to various styles and teaching methods. • Providing opportunities to creatively expand teaching methods. • Immersing in yoga by customizing the virtual environment.	• Exposure to various educational opportunities and methods • Promoting yoga immersion	• Possibilities due to • Observability	

• There might be a learning curve for both instructors and trainees to navigate the metaverse platforms. • Small studios might struggle without access to or support for the metaverse technology. • Technical glitches could disrupt the flow of the metaverse yoga classes." • Assessing and correcting yoga poses might be more challenging in the metaverse. • The cost of accessing the necessary technology could be a barrier for some trainees. • No matter how advanced the technology, the essence of physical presence in yoga teaching is irreplaceable.	• There is a learning curve. • Access to the metaverse is limited. • There are technological limitations. • There is a cost issue.	• Existence of a learning curve. • Limited access. • Technological • Limitations • Cost issue	Limitations due to triability	Limitations
• Financial stability might be a concern with yoga classes due to fluctuating online engagement. • Creating a sense of community might be challenging in the virtual space of yoga. • Privacy concerns in the metaverse could deter some from participating in virtual yoga classes. • Immersion might be challenged by the lack of physical presence and touch, which are integral to traditional yoga teaching methods.	• There may be problems with the financial stability of yoga classes. • Building a sense of community can be difficult in virtual spaces. • Problems related to the protection of personal information may arise. • Lack of physical presence and contact can make immersion difficult.	• Financial stability • Difficulty forming a sense of community • Personal • information security • Immersion problem	Limitations due to complexity	

Trainee's perception of the possibilities and limitations of yoga in the metaverse: Table 4 presents the 20 main statements of yoga trainees who participated in the focus group interview and the classification of formulated meaning, themes, and theme clusters accordingly.

Ultimately, yoga in the metaverse as perceived by yoga trainees was categorized into possibilities and limitations. Specifically, the possibilities due to relative advantage, compatibility, triability, and observability recognized by yoga trainees can be summarized as follows. Yoga in the metaverse can offer the potential to expand the target audience beyond traditional boundaries, allowing practitioners to overcome the constraints of time and place, utilize the platform's scalability for larger classes, and leverage its connectivity for a seamless experience. It opens the door to creative and varied class formats, harnesses a range of technologies to deepen practice, and caters to the growing interest and curiosity in virtual spaces. Furthermore, yoga in the metaverse enhances the meditative aspects of yoga by providing an immersive environment and the possibility of unique sensory experiences, transforming how yoga is practiced and experienced. Meanwhile, their perception of specific limitations due to triability and complexity is as follows. Yoga in the metaverse faces several constraints, including concerns about personal information protection and data security within virtual spaces. The transition to a digital platform may lead to a loss of the sense of community often found in physical yoga studios. Participants might experience a lack of motivation to exercise without in-person encouragement, may require specific equipment for an immersive experience, and could suffer from poor instructor guidance due to the virtual barrier. The costs and accessibility of VR technology could limit participation, excluding those without the means or access to such equipment. Technical or connectivity issues may impede the fluidity of classes, and there are concerns that the quality of yoga instruction could decline without the most nuanced guidance possible in a physical setting. Lastly, there's an apprehension that the typical yoga practice might be difficult to replicate authentically in the metaverse, potentially impacting the overall experience (Table 4).

DISCUSSION

Despite the recent slowdown, the metaverse is still in its nascent stages. The development of content within the metaverse is expected to invigorate related industries, leveraging its boundless potential across various domains in the future. A crucial aspect of the metaverse environment is the creation of content that allows for diverse experiences, including yoga, which serves as a significant exercise activity for mental peace and physical health enhancement. Meanwhile, this study highlights the psychological benefits of yoga, such as the release of beneficial brain chemicals, reduction of stress, and improvement in overcoming anxiety, depression, and the improvement of sleep quality [49]. Particularly during the COVID-19 pandemic, yoga has been shown to effectively alleviate stress, anxiety, and sadness [50], making it noteworthy content for the metaverse. The metaverse space has been explored for rehabilitation exercises, examining the possibilities and limitations through expert Delphi studies [51]. Furthermore, the potential of yoga exercises within the metaverse can guide postures and use avatars to assist participants' yoga performance, thereby providing motivation for mental and physical enhancement [52].

This study measured the metaverse's correlation with various activities using the Pearson coefficient, finding strong ties with gaming and moderate ties with education and exhibitions. However, the relationship with yoga is insignificant, indicating a lack of public engagement within Korean society compared to gaming, concerts, sports, and education.

Table 4: Perceptions of a focus group of yoga trainees.

Significant statements	Formulated meaning	Themes	Theme clusters	Category
• There's potential for more inclusive yoga classes that cater to people with physical limitations. • Yoga in the metaverse might attract a younger, more tech-savvy demographic. • The ability to practice yoga without the constraints of time and location is appealing.	• Possibilities for comprehensive yoga classes. • Potential to attract a young, tech-savvy demographic. • Ability to practicing yoga without restrictions due to time and place.	• The possibility of expanding target audience. • Overcoming time and place constraints	• Possibilities due to relative advantage	
• The metaverse's scalability might lead to larger yoga classes. • The metaverse could provide opportunities for global yoga events, connecting practitioners worldwide.	• Possibility of providing larger yoga classes. • Possibility of providing opportunities for global yoga events, connecting practitioners worldwide.	• Possibility of utilizing the metaverse's scalability. • Potential utilization of the metaverse connectivity.		Possibilities
• Yoga in the metaverse could allow for creative class formats that aren't possible in a traditional studio. • Utilizing various technologies could make yoga more engaging and enjoyable.	• Possibility of creative class formats. • Possibility of providing more engaging and enjoyable yoga classes.	• Acceptability of creative class formats. • Possibility of utilizing various technologies.	• Possibilities due to • Triability	
• The metaverse is interesting and I understand its potential. • The prospect of attending yoga classes in exotic virtual locales is exciting. • The immersive virtual environments might enhance the meditative aspects of yoga. • The metaverse could offer unique sensory experiences that enhance relaxation and focus during yoga.	• Interest and understanding of the metaverse. • The prospect of attending yoga classes in the metaverse. • Expectations of enhancing flow in yoga. • Expectations of a unique sensory experience for relaxation and concentration.	• Interest and understanding of the metaverse. • Curiosity about the metaverse. • The usefulness of meditation in yoga in an immersive virtual environment. • Possibility of providing unique sensory experiences in the metaverse.	• Possibilities due to • Observability	
• Privacy and data security in the metaverse are significant concerns for me. • I worry about the impersonal nature of metaverse yoga and the potential loss of community feeling. • In an online setting, there could be a lack of motivation to exercise, a need for equipment, and an absence of direct instructor guidance. • The cost and accessibility of VR technology could be barriers to participation for some.	• Concerns about privacy and data security in the metaverse. • Concerns about loss of sense of community during yoga in the metaverse. • Concerns about lack of motivation to exercise, need for equipment, and direct instructor guidance. • Concerns that the cost and accessibility of VR technology may be a barrier to participation.	• Metaverse's personal information protection and data security. • Loss of sense of community. • Lack of motivation to exercise, need for equipment, poor instructor guidance. • Limited participation due to cost and accessibility of VR technology.	Limitations due to triability.	Limitations
• Technical issues or connectivity problems could disrupt the flow of a yoga session. • There's a concern about the quality of yoga instruction being diluted in a virtual format. • Assessing proper form and technique in yoga poses might be challenging without physical presence.	• Technical issues or connectivity problems. • Concern about the quality of yoga instruction. • Concerns about the difficulty of practicing yoga in virtual spaces.	• Limitations due to technical or connectivity issues. • Concerns about the decline in quality of yoga classes. • Concerns about the difficulty of typical yoga practice.	Limitations due to complexity	

This suggests yoga has not yet been widely embraced in the virtual realm, prompting further investigation into the perceptions of yoga professionals and practitioners regarding its metaverse integration.

Accordingly, this study conducted focus group interviews with five yoga instructors and five yoga trainees to examine their perceptions of yoga in the metaverse. Both yoga instructors and trainees perceive yoga in the metaverse as a field ripe with possibilities and challenges. They agree on the potential for expanding the audience, providing accessibility for those with disabilities, and the benefit of anonymity. The possibility of gamification to enhance motivation and the ability to create a more engaging learning environment through the metaverse's interactivity are seen as significant advantages. They also share concerns regarding the challenges in creating community, maintaining the quality of yoga instruction, the necessity for specific VR equipment, and potential issues with data security and personal information protection.

However, there are nuances in their perspectives. Yoga instructors emphasize the potential to transform yoga practice and pedagogy by diversifying teaching techniques and customizing virtual environments. They seem to be looking at the broader pedagogical implications of yoga in the metaverse. Yoga trainees, on the other hand, highlight the enhancement of yoga's meditative aspects through immersive environments and unique sensory experiences, suggesting a focus on the personal, experiential benefits of practicing yoga in the metaverse.

In terms of limitations, instructors are concerned about the learning curve and technological barriers that could deter newcomers, while trainees worry more about the loss of physical presence and the authenticity of yoga practice in a virtual setting. Instructors appear to be considering the practical aspects of conducting classes, whereas trainees are more focused on the personal experience and the potential loss of the essence of traditional yoga practice.

Overall, both groups see the metaverse as a double-edged sword for yoga, offering innovative ways to practice and learn while presenting new challenges that need to be addressed to preserve the integrity and essence of yoga.

As a result, yoga in the metaverse presents a valuable opportunity for practitioners who may find it challenging to gather due to spatial and temporal constraints, such as the elderly, residents of remote or rural areas, and island inhabitants. As the metaverse emerges as an innovative digital universe, it redefines interactions between trainees and their environments [53]. At its core, the metaverse integrates VR, AR, and other immersive platforms, creating a seamless connection between the physical and virtual worlds. This digital universe facilitates real-time interactions, not only among trainees, but also with various digital objects, blurring the traditional boundaries between reality and virtuality. The applications of the metaverse span socialization, entertainment, education, and, notably, physical activities like exercise [54].

In the domain of physical health, numerous studies underscore the metaverse's potential to revolutionize exercise routines, exploring various virtual physical activities from interactive exercises and sports simulations to more holistic practices like yoga. The metaverse's key advantage is its ability to transcend the usual constraints of time and place, offering a highly personalized fitness experience by allowing individuals to engage in physical exercises within virtual spaces, customize their workout environments, and choose instructors based on their preferences [55]. Yoga, emphasizing physical balance, flexibility, and mindfulness, is well-suited for realization within the metaverse [56].

However, for yoga to become established in the metaverse within Korean society, changes are necessary to address the identified limitations and to capitalize on the potential of this technology. First, there is a need to overcome technological barriers by enhancing user interface simplicity and ensuring that the technology is user-friendly for all levels of technical skill. Second, cost issues must be addressed by providing affordable access to necessary hardware and software, potentially through subsidies or partnerships with technology providers. Third, creating virtual spaces that replicate the community feel of a yoga studio, possibly by incorporating social features that allow interaction and the formation of relationships among participants. Fourth, ensuring that virtual yoga classes maintain the quality of instruction, perhaps through rigorous training for instructors on how to teach effectively in the metaverse and using technology that allows for detailed observation and correction of yoga poses. Fifth, implementing robust security measures to protect users' personal information and to build trust in the use of the metaverse for yoga practices. By addressing these areas, the integration of yoga into the metaverse can be more effective, providing an inclusive, accessible, and authentic experience that has the potential to be well-received within Korean society. Furthermore, our findings indicate that yoga in the metaverse has potential for rehabilitation by guiding postures with avatars and offering mental and physical enhancement. The metaverse's adaptability can support diverse rehabilitative needs, offering personalized, engaging experiences beyond physical limitations.

CONCLUSION

This study identified a disparity in the South Korean metaverse's relationship with various activities. While gaming and education show moderate to strong correlations, yoga has an insignificant relationship, suggesting a lack of integration into virtual spaces.

Accordingly, this study selected yoga instructors and yoga trainees as a focus group, conducted interviews, and examined their perceptions of yoga in the metaverse based on the theory of Rogers EM. According to the results, there's potential for yoga in the metaverse to offer wider access, especially for those with disabilities, and to provide a more engaging learning environment through gamification and interactive features. However, to establish yoga firmly in the Korean metaverse, changes must address technological and cost barriers, ensure the quality and reliability of virtual platforms, and preserve the community aspect and authenticity of yoga practice. This would involve enhancing user interfaces, making yoga economically accessible, creating virtual communities, maintaining instructional quality, and ensuring data privacy. These changes are crucial to realize the potential for a more inclusive and engaging yoga practice within

the metaverse, catering to the growing interest in digital wellness practices.

This study suggests three major implications for yoga in the metaverse. Firstly, there's an opportunity for yoga to reach a broader demographic, including those with disabilities or in remote locations, by leveraging the metaverse's accessibility. This could democratize wellness and potentially foster a new wave of health-focused virtual communities. Secondly, as the metaverse's technology evolves, it could provide innovative platforms for yoga instruction and practice, creating environments that enhance the meditative and physical aspects of yoga. The use of gamification could significantly improve engagement and motivation among users. Lastly, this study shows that the successful incorporation of yoga into the metaverse requires addressing privacy concerns, improving the sense of community in virtual spaces, and ensuring the quality of instruction. Without careful consideration of these factors, the essence of yoga could be compromised, leading to a decline in its effectiveness and popularity in the metaverse.

However, our limitations included a potential bias stemming from the specific cultural context of South Korea, which may not reflect global attitudes towards yoga in the metaverse. Secondly, the study may have limited insight into long-term engagement patterns as the metaverse and its applications are still evolving. Lastly, the focus on qualitative data from interviews may overlook quantitative metrics that provide a broader understanding of user interaction with yoga in the metaverse, such as engagement time, user retention rates, and overall satisfaction.

Future research on yoga in the metaverse needs to explore global attitudes to understand cross-cultural adoption and engagement, including longitudinal studies to track long-term user behavior and quantitative analyses focusing on metrics like user retention, engagement time, and satisfaction. This would offer comprehensive insights into the efficacy and popularity of virtual yoga practice worldwide. Also, this study implies that yoga in the metaverse may enhance accessibility, especially for those with disabilities, and offer engaging learning through gamification, requiring consideration of technological and privacy issues for successful integration. Therefore, follow-up research requires additional analysis of the possibility of yoga in the metaverse being utilized in the rehabilitation field.

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