

From Play to Workout: How VR Fitness Game Design Enhances User Engagement?

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ABSTRACT

Virtual reality (VR) gaming has become a beneficial tool in health management. However, the specific mechanisms through which VR games influence users' regular engagement with VR fitness games remain underexplored. This study integrates the uses and gratifications theory into our research model to investigate the relationships between VR design features (presence, immersion, and interactivity) and the routine use of VR games, mediated by users' gratifications. Data collected via an online questionnaire and empirical analysis revealed that VR design features significantly impact the routine use of VR fitness games by enhancing user gratification. Detailed analysis indicates that presence plays a crucial role in informational gratification, interactivity significantly affects health gratification, and immersion is pivotal for emotional gratification. These findings highlight the importance of targeted design features in satisfying user needs and promoting the routine use of VR for health enhancement.

Keywords: Virtual reality, health behavior change, use of gratification theory, application design features.

INTRODUCTION

Virtual reality (VR) has emerged as a new way for health management. Compared with gamified mobile applications, VR's ability to present comprehensive and rich information could make physical activity more engaging and enjoyable, potentially increasing motivation and adherence to exercise routines. By simulating various scenarios, VR can provide diverse workout experiences, from yoga to high-intensity interval training, without leaving the comfort of one's home. This not only makes fitness more accessible but also helps in overcoming the monotony of traditional workouts, thereby contributing to improved physical health and psychological well-being (Alturki & Gay, 2019). However, the relatively low rate of adoption and the limited selection of available software still weaken the full potential of VR to enhance health outcomes (Petrov, 2024). Consequently, comprehending the strategies to encourage sustained user engagement with VR fitness games is crucial for enhancing health outcomes.

Previous studies have mostly examined the effects of VR applications on health outcomes and patient education (Sokołowska et al., 2024), with only a few studies examined the determinants that influence the use of VR fitness games (Shen et al., 2022). For instance, Ball et al., (2021) posited that environmental factors significantly influence VR adoption. However, most prior studies investigate the determinants from an individual perspective, limited studies concentrate on the design features and the long-term impact of design features of VR on user behavior (Dehghani et al., 2022). Given that the design features of VR fitness games can directly impact individuals' perceptions, they may consequently have a significant effect on the habitual usage patterns of users. As a result, this research aims to investigate the underlying mechanisms that promote habitual usage behaviors, with a particular focus on how the design of VR games can encourage the routine use of VR as a tool for health management. This study aims to fill this research gap and explore how the design features of VR fitness games affect users' habituated usage behaviors, especially how to promote the routine use of VR as a health management tool through design features such as immersion, interactivity, and presence. Although the current literature has revealed some effects of VR on user behavior, the discussion of its influence mechanism is still insufficient. Most studies only focus on the correlation between design features and behavioral outcomes and focus on the user perspective. There is a lack of in-depth analysis of how these design features contribute to long-term health management through users' intrinsic motivation and need satisfaction. In this regard, the goal of this study is to explore how VR design features provide users with gratification through intrinsic psychological mechanisms, and thus promote sustainable health behaviors.

To address our main objective, we first identify the design features of VR (immersion, presence, and interactivity) drawing on insights from prior studies (Mütterlein, 2018). Then, since the impact of VR on individual behavior stems from meeting users' needs, we adopt the uses and gratifications theory as the theoretical foundation for this study. We hypothesize that presence, immersion and interactivity significantly shape users' experiences by meeting their informational, emotional, and health-related gratifications. We then explore how the design features of VR fitness games meet user needs and the manner in which these needs influence behavior patterns.

This study employed a survey method, and the results revealed that VR fitness game design significantly affects routine use behavior. Interestingly, an in-depth examination revealed that presence is essential for informational gratification, interactivity is critically linked to health-related gratification, and immersion plays a critical role in emotional gratification. By analyzing the relationship between VR game design features and routine use of VR fitness games, this study offers valuable design guidance for game developers and presents a new perspective for public health interventions.

LITERATURE REVIEW ON VR IN HEALTHCARE

Previous studies have highlighted the efficacy of mobile health apps in enhancing health behaviors through features like monitoring and rewards (Ghose et al., 2021; Jiang et al., 2020). However, while these apps are effective in the short term and drive healthy behavior change, not all interventions sustain active engagement. Some apps may even weaken users' intrinsic motivation and lead to poor long-term results. (Voth et al., 2016). This emphasizes the need for designing m-health interventions that foster long-term engagement and intrinsic motivation in physical activities.

At the same time, the application of VR in the field of healthcare is gradually expanding. VR consists of computers or mobile devices with interactive 3D visualization graphics, controllers, and head-mounted displays embedded with positional trackers (Akinola et al., 2020). Its unique sense of immersion, presence and interactivity provides an unprecedented experience for health interventions. Compared to traditional m-health applications, VR not only allows users to experience virtual environments through light and sound, but also allows users to be more focused on tasks, which in turn enhances the levels of engagement. In the e-health literature, VR has been considered a tool for health interventions or incentive strategies to facilitate changes in patients' health behaviors. However, previous studies on VR in healthcare primarily focus on its effects on health outcomes (e.g., mental health, health status) or patient education (Sokołowska et al., 2024), with limited research on the determinants of individual's behavior.

Additionally, our review indicates that the effective design of m-health applications is crucial for accepting health interventions. Therefore, exploring the impact of VR fitness games on their routine use from a design feature perspective is essential for understanding VR's effects in healthcare. Drawing upon prior studies, this study proposes three design features of VR: immersion, presence, and interactivity (Mütterlein, 2018). Presence in VR refers to the feeling of actually being in a virtual environment where the user's perceptual system is fully engaged and their brain and body systems automatically respond to stimuli as if they were real (Mütterlein, 2018). Immersion refers that when users are immersed in a VR environment, their senses are fully engaged, thus, creating a more realistic virtual experience (Mütterlein, 2018). Interactivity enhances the user's sense of engagement through real-time feedback and dynamic responses, especially in health-related VR applications (Mütterlein, 2018).

THEORETICAL FOUNDATION AND HYPOTHESES DEVELOPMENT

Use and gratification theory (UGT) posits that individuals actively choose media based on their needs for information, entertainment, and social interaction, leading to purposeful and rational media use (Papacharissi & Rubin, 2000). UGT has been applied across communication research, marketing, content creation, and social media, aiding in understanding audience motivations, shaping content production, and enhancing user experience (Keelson et al., 2024). It helps explain the motivations and satisfactions behind media usage, ultimately improving communication and user engagement.

UGT is well-suited for our study to explain the influence of VR design features on routine use. First, UGT emphasizes that users engage with media to satisfy specific gratifications (Xu et al., 2023). According to previous studies, we chose informational gratification, emotional gratification and health gratification (Pham et al., 2020) as the measurement of user experience. The reason that we chose these dimensions is that they can well explain the different needs and motivations of VR users. Under the framework of use and satisfaction theory, these design features have a strong correlation with user experience and can effectively meet users' cognitive, emotional and health needs. By meeting these needs, users will generate higher engagement and intrinsic motivation when using VR fitness games, thus promoting their long-term and habitual use. Our study proposes that VR design features such as immersion, presence, and interactivity can significantly enhance the user experience by fulfilling their informational, emotional, and health gratifications, thereby driving sustained use. Second, routine use of VR fitness games requires strong motivation, which can stem from intrinsic goals like personal health or extrinsic rewards. UGT provides a framework to understand why these design features generate strong user motivations, leading to long-term and regular use. Therefore, using UGT to explain the impact of VR design features on routine use helps reveal the relationship between gratification satisfaction, motivational drivers, and sustained usage, offering theoretical support for designing more effective VR fitness games.

Based on the UGT, this study proposes that the main user gratifications in VR fitness games, including information, health, and emotion, are driven by VR's presence, interactivity and immersive experiences. Information gratification describes the fulfillment users get from acquiring information and knowledge through a particular medium or experience. Health gratification enhances physical fitness through engaging gameplay while minimizing travel costs and space requirements,

providing effective exercise guidance. Emotional gratification arises from the entertainment and emotional experiences of gameplay.

Presence in virtual reality (VR) can create an immersive and engaging experience. The sense of presence reflects the high degree of restoration of virtual reality to the real environment, thus, users can explore and interact with the virtual world in a natural and intuitive way. Users' brains would process information more deeply when they are fully immersed in the virtual environment, which just like the real world. This multi-sensory feature (visual, auditory, and sometimes even tactile) contains a greater amount of information and helps users focus and absorb content more efficiently. This immersive emotional response is much stronger than in traditional media. In traditional media, the user is still a passive observer, but in VR, the user experience becomes personalized and real due to the sense of presence, and the user is more emotionally engaged, thus gaining emotional satisfaction while enjoying the feeling of excitement, relaxation or emotional connection. Finally, when the experience feels immersive and fun, rather than monotonous or repetitive, users may be more motivated to exercise or participate in physical therapy. Studies have shown that presence increases user satisfaction and influences consumer behavior (Lo & Cheng, 2020). Therefore, the following hypotheses can be clarified:

H1a: The presence feature of VR has a positive impact on users' informational gratification.

H1b: The presence feature of VR has a positive impact on users' emotional gratification.

H1c: The presence feature of VR has a positive impact on users' health gratification.

Immersion refers to the user's deep interaction and engagement with the virtual environment, where they are completely immersed and forget about the real world. The immersion of VR systems mainly depends on sensory immersion, that is, the degree of stimulation of virtual simulation to the user's sensory channels. It has been proven to enhance learning, exercise motivation, and emotional engagement (Lin et al., 2017). Immersive experiences enhance informational gratification through flow (a state of mind where people are fully engaged in a task), and they are more likely to learn and remember information effectively. Immersive virtual reality can also create a sense of escape, where users temporarily escape the pressures of the real world and immerse themselves in another reality, gaining emotional gratification through pleasure and relief. In fitness apps, immersive VR environments can make fitness activities, or rehabilitation exercises fun and inspiring. For example, when users are immersed in a virtual world, they may be more motivated to do exercises, because the activities in the virtual world are more like games than chores. The deep focus that comes with immersion can also enhance the connection between body and mind, allowing users to reduce stress or anxiety. Therefore, the following hypotheses can be clarified:

H2a: The Immersion feature of VR has a positive impact on users' informational gratification.

H2b: The Immersion feature of VR has a positive impact on users' emotional gratification.

H2c: The Immersion feature of VR has a positive impact on users' health gratification.

Interactivity in virtual reality (VR) refers that users can actively participate in a virtual environment through actions that generate immediate feedback and response. Interactivity allows users to actively engage with content rather than passively consume information, which significantly increases information satisfaction. When users can manipulate elements in a VR environment, such as exploring objects, browsing scenes, or solving problems, they gain a deeper understanding of the material. Interactivity can also enhance emotional satisfaction, giving users a more meaningful and personalized experience. When users can make choices in a VR environment that affect the narrative or outcome, they feel a greater sense of initiative and engagement with the experience. Finally, because users can get timely feedback and guidance by interacting with actions in the virtual environment. This real-time interaction allows the user to adjust the movement according to the response of the system, thus improving the efficiency of the movement. In addition, interactivity enhances the combination of senses and actions, enabling users to obtain a more immersive sports experience in a virtual environment, effectively stimulating exercise motivation and persistence, thus, further improving physical health. Interactivity, especially with natural user movements, improves learning outcomes, scene credibility, and emotional experiences (Pallavicini, et al, 2019 ; Yang et al., 2010) according to previous studies. Therefore, the following hypotheses can be clarified:

H3a: The Interactivity feature of VR has a positive impact on users' informational gratification.

H3b: The Interactivity feature of VR has a positive impact on users' emotional gratification.

H3c: The Interactivity feature of VR has a positive impact on users' health gratification.

UGT explains users' continuous motivation when using new media tools and predicts their usage behavior based on the gratifications they receive. Users who derive greater gratification from VR games are more likely to continue using them. VR fitness games often provide the user with feedback on their progress, such as calorie burn, or improvement in exercise skills. This feedback can help users better understand their physical abilities and track their development. Information gratification occurs when users feel they have gained valuable knowledge or learned new skills by engaging in VR fitness games. Thus, they would likely to continue to use these apps. In social media, information seeking, motivation, and brand liking significantly positively impact customer engagement behavior (Kamboj, 2019). Besides, VR fitness games often provide an entertainment element that makes exercise less like a chore and more like a pleasurable activity. This emotional gratification encourages users to return to these games on a regular basis, thus enhance the routine uses of VR fitness games. Gratifications serve as crucial psychological incentives for the sustained utilization of Ant Forest (an environmental app) (Mi et al., 2021). Emotional gratification derived from media entertainment, encompassing simple enjoyment to intricate social and cognitive fulfillment, promotes media consumption (Bartsch & Viehoff, 2010). At last, VR fitness games make exercise more engaging and fun,

helping users maintain consistent fitness habits. When users notice tangible physical or mental health improvements, they are more likely to continue using VR fitness games as part of their daily fitness routine. As the research found that exercise needs positively correlate with users’ willingness to keep playing sports games (Pham et al., 2020).Therefore, the following hypotheses can be clarified:

H4a: The informational gratification has a positive impact on users’ routine uses of VR fitness games.

H4b: The emotional gratification has a positive impact on users’ routine uses of VR fitness games.

H4c: The health gratification has a positive impact on users’ routine uses of VR fitness games.

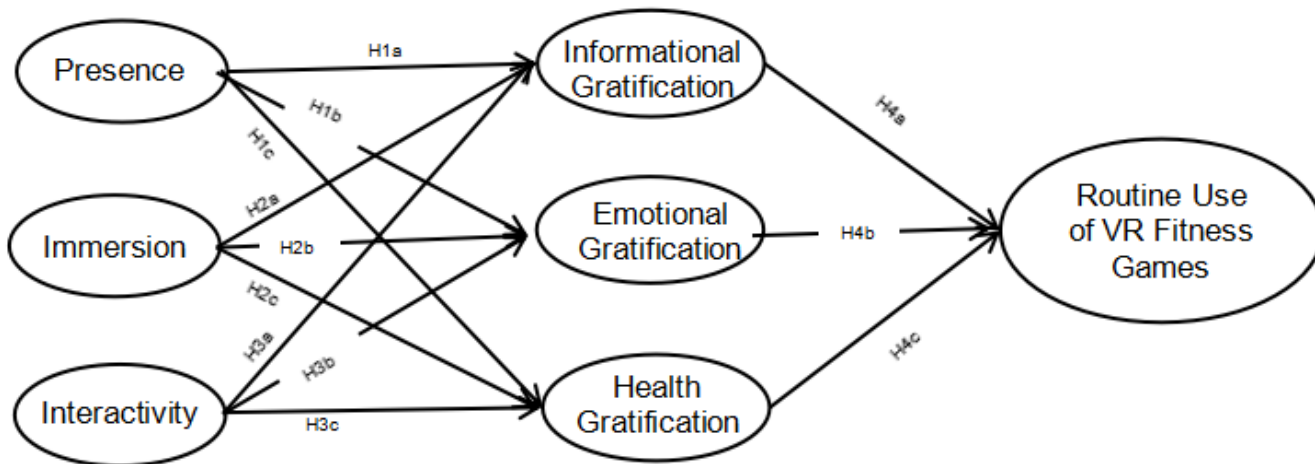


Figure 1: Research Model.

RESEARCH DESIGN

Data Collection

This study uses a survey method to explore how VR fitness game design influences health behavior change. Data were collected through an online questionnaire distributed randomly among undergraduate students, a group actively embracing new technologies and media, making them ideal for examining VR gaming trends. Focusing on college students also helps mitigate variables like age and education level, streamlining model construction and data analysis. We first invite participants to watch a simulation video of “Sizzling Moment” (Figure 2) via a provided link in the questionnaire and then completed the survey based on their experience. “Sizzling Moment” is a free boxing VR game on the PICO VR platform, recognized with a 40% vote rate in the 2022 “VR Application of the Year” list, reflecting its popularity among users and in the market. This game serves as the foundation for our questionnaire. A total of 252 questionnaires were collected for this study.



Figure 2: “Sizzling Moment” Game Screenshot.

Survey Instrument

To ensure the reliability and validity of our measurements, this study initially reviewed relevant literature and adjusted measurement items to fit the context of VR games. Subsequently, professionals were invited to review these measurements. Each measurement item was evaluated on a 5-point Likert scale (1=strongly disagree; 5=strongly agree).

agree). Measurement of immersion in VR games was adapted from the immersive experience questionnaire by Jennett et al. (2008), assessing users' immersion across visual, auditory, motor, and emotional dimensions. Presence measurement, assessing users' realism and existence in the virtual environment, drew from Slater et al. (1994). Interactivity measurement utilized the user engagement scale by O'Brien et al. (2010), focusing on interactive behaviors between users and the virtual environment. Measurement items for information gratification were derived from Sung et al.'s research, while those for health gratification were based on studies by Lovell et al. (2010) and Wu et al. (2010), and emotional gratification items were sourced from Wu et al. (2010).

DATA ANALYSIS AND RESULTS

We use SmartPLS4 for structural equation modeling to effectively analyze moderating and mediating variables. The validity of the measurement model was assessed through factor loadings of observed variables and the Average Variance Extracted (AVE) of latent variables, with a threshold set at 0.5 for both. Discriminant validity was evaluated using the Fornell-Larcker Criterion, requiring each latent variable's AVE's square root to exceed its correlation coefficients with other latent variables. Reliability was evaluated using Composite Reliability (C.R.) and Cronbach's Alpha, with a critical value of 0.7 for both measures. Collinearity in the structural model was diagnosed using the Variance Inflation Factor, with a threshold of 5. Path coefficients were assessed using a two-tailed test at a significance level of 0.05. R Square values measured the explanatory power of exogenous variables on endogenous variables, while the predictive efficacy of the model was validated using f-square and Q-square values. The measurement model demonstrated strong internal consistency and composite reliability, with coefficients and C.R. values exceeding 0.7 for all latent factors. Convergent validity was confirmed as all observed variable loadings and AVE values surpassed the designated thresholds. The Fornell-Larcker Criterion indicated satisfactory discriminant validity within the measurement model.

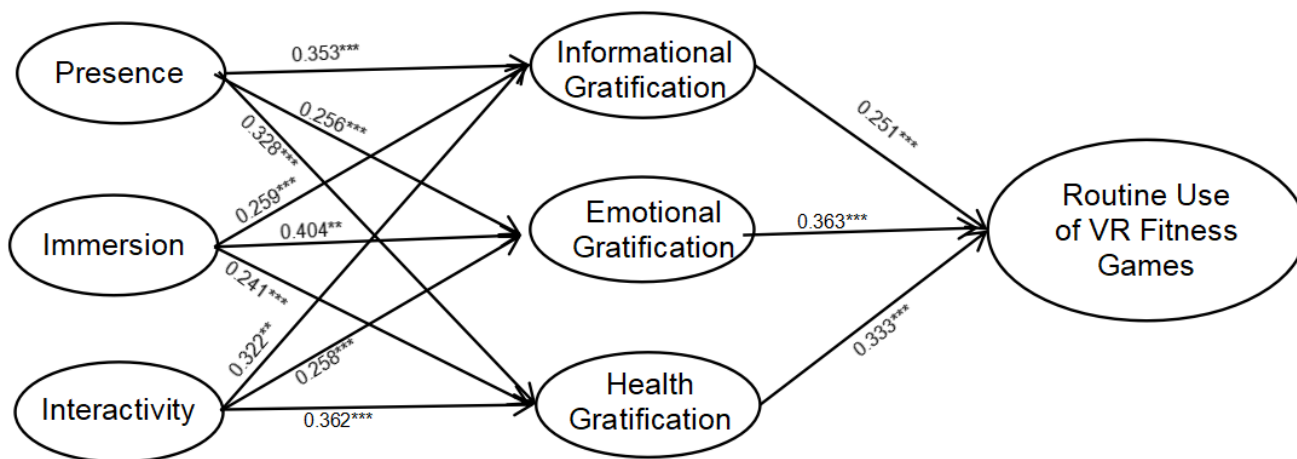


Figure 3 Theoretical Model and Empirical Analysis Results

The analysis results are shown in Figure 3 and indicate that immersion, presence, and interactivity significantly and positively influence informational, emotional, and health gratification (p-value <0.001). Informational, emotional and health gratification is significantly associated with routine use of VR fitness games (p-value <0.001). Interestingly, we observed that the coefficient for presence is highest in the relationship between design features and informational gratification. Immersion exhibits the highest coefficient for emotional gratification. In terms of health gratification, interactivity shows the highest coefficient.

DISCUSSION AND IMPLICATIONS

Our analysis revealed that three design features significantly influence user gratification. These findings are consistent with previous research on the positive impact of VR design features on individual decisions (Azarby & Rice, 2022; Kang et al., 2020; Kim et al., 2021).

Second, gratifications serve as the mediator between VR game design features and user gratification. In this regard, VR game design features not only directly impact users' gratification, but also affect users' routine use indirectly. The finding that VR game design features are related to user gratification is consistent with past research, but past research did not mention an indirect relationship between VR and user habitual usage behavior.

Third, further analysis indicated that presence has the greatest effect on information gratification, interactivity was most influential for health gratification, and immersion had the largest impact on emotional gratification. These insights reveal the importance of specific design features in fulfilling user needs and promoting the regular use of VR for health benefits.

Theoretical implications

This study makes two significant theoretical contributions to VR and e-health literature. First, this study provides a detailed examination of how various design features of VR fitness games influence users' routine use of VR fitness games. By analyzing features such as immersion, interactivity, and presence, this study sheds light on the direct relationships between VR design features and sustained engagement in health-related activities. For example, immersion not only enables users to experience a virtual fitness environment in an immersive way, but also improves workout results by reducing distraction. Interactivity, on the other hand, gives the user more control and personalization options, which in turn increases the sense of dependence on the game. In addition, the enhanced sense of presence allows users to get experiences that are close to reality in VR games, which further promotes their motivation to participate in healthy activities. Second, this study examines the psychological mechanisms through which VR design features influence user behavior, particularly intrinsic gratification. Users' experience in virtual reality can satisfy their internal needs, including informational gratification, emotional gratification and health gratification, which in turn encourages users to continue to participate in health activities. It explains how meeting users' internal desires and needs during VR experiences can foster continuous engagement in health activities, offering a novel perspective on the motivational aspects of VR engagement.

Managerial implications

As VR is widely used in the field of health, understanding how to optimize the user experience through VR design features can help managers meet user needs and improve user satisfaction and loyalty more effectively. Based on the findings, there are two key managerial implications. First, managers should focus on the three critical design features—presence, immersion, and interactivity—as these significantly influence user needs and routine use of VR. By understanding which design features are most impactful for different types of gratification, managers can tailor VR experiences to better meet user expectations and drive engagement. Second, the distinct effects of presence on information gratification, interactivity on health gratification, and immersion on emotional gratification suggest that VR applications should be developed with targeted design strategies. For example, for users who want to get health information, the presence of VR games should be enhanced. Identifying which design features are most likely to increase user engagement and satisfaction helps managers better allocate resources to focus on the most impactful design features and increase ROI. Managers can leverage this insight to create VR experiences that are engaging and effective in promoting health behavior change.

Limitations and future work

This study acknowledges certain limitations that must be addressed in future research. Firstly, the sample size was relatively small, which may limit the generalizability of the findings. Efforts will be made to collect a larger dataset to enhance the robustness of the results. Second, participants were invited to watch videos, which may not accurately reflect the immersive experience of actual VR gameplay. To overcome this, we have invested in VR equipment and plan to conduct future studies where participants will engage in VR gameplay before completing the data collection process. Third, relying solely on surveys to comprehend the causal relationship between VR immersion, presence, interactivity, and health benefits has its limitations. To overcome this, future research should integrate wearable sensors and biometric-driven algorithms to capture and validate hypotheses or use a randomized controlled trial. This approach will yield more robust and controlled data, further advancing our understanding of the effects of VR experiences on health behavior. These steps are expected to enhance our understanding of the VR experience and its impact on health behavior.

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APPENDIX A: Question Design

Dimensions	Measure Items		References
Immersion (IM)	IM1	I find the game really grab my attraction	(Jennett et al., 2008)
	IM2	I ignored the time when I was playing the game.	
	IM3	I ignored what was going around me while playing the game	
Presence (PR)	PR1	This game feels real.	(Slater et al., 1994)
	PR2	I think the sound in the game is the same as in reality.	
	PR3	I forgot I was in a virtual environment.	
Interactivity (IN)	IN1	It found it easy for me to become proficient in VR games.	(O'Brien et al., 2010)
	IN2	Out of curiosity, I want to play in this game.	
	IN3	I feel like I am in the game.	
Informational Gratification (IG)	IG1	I get information about sports or services through games.	(Sung et al., 2010)
	IG2	Through the game I gained useful information that I didn't know before.	
	IG3	I learned information related to my sports interests through the game.	
Health Gratification (HG)	HG1	I think it's important to improve my sport in VR games.	(Wu et al., 2010)
	HG2	My endurance increased after working out in the game.	(Lovell et al., 2010)
	HG3	My mental alertness increased after I exercised in the game.	
	HG4	I feel relaxed after exercising in the game.	
Emotional Gratification (EG)	EG1	I have more power in VR games than other players.	(Wu et al., 2010)
	EG2	I think playing VR games gives me a lot of fun.	
	EG3	My online friends know me better than anyone else.	
Internal Behavior (IB)	IB1	I had a certain amount of fun, and I was able to follow the rules during use.	(Haiyun (Melody) Zou et al., 2018)
	IB2	I enjoyed it and actively explored the game.	
	IB3	I really enjoyed it and hope to play again.	