Örgütsel Davranış Araştırmaları Dergisi
Journal Of Organizational Behavior Research
Cilt / Vol.: 8, Sayı / Is.: 2, Yıl/Year: 2023, Sayfa/Pages: 261-280
https://doi.org/10.51847/8OnKjAVQFX
2528-9705

VIRTUAL REALITY IN LEISURE: ITS IMPACT ON SOCIAL INTERACTION AND PHYSICAL ACTIVITY AMONG SAUDI UNIVERSITY STUDENTS

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ABSTRACT

The primary objective is to explore how regular Virtual Reality usage affects students' perceptions of Virtual Reality as a leisure tool, social interactions, and physical activity levels. The study adopted an explanatory cross-sectional survey design, the research involved 658 university students selected through a stratified random sampling technique, ensuring a balanced representation of gender and diversity in academic majors. The instrument employed in this study was a structured questionnaire consisting of two parts: demographic information and three core factors about Virtual Reality's impact on leisure. Before administration, the questionnaire underwent thorough validation for validity and reliability. Descriptive statistical techniques and exploratory and confirmatory factor analysis were utilised to analyse the data, ensuring comprehensive reliability and accuracy of the findings. The study's analysis revealed three key findings: Firstly, regular Virtual Reality usage in leisure significantly enhances university students' positive perceptions of VR as a leisure tool. Secondly, it considerably alters their social interaction patterns, enhancing virtual connectivity and impacting real-world social engagements. Lastly, Virtual Reality use has a dual impact on physical activity levels, encouraging active engagement in some scenarios while potentially fostering sedentary behaviours. These findings collectively paint a comprehensive picture of VR's multifaceted influence in leisure contexts among university students. Based on these main findings, the study offers theoretical and practical implications. Limitations were identified, and recommendations for further research were also suggested.

Keywords: *Leisure, Physical activity, Saudi university students, Social interaction, Virtual reality.*

INTRODUCTION

Virtual reality (VR) has evolved as a transformational technology in today's digital ecosystem, particularly in entertainment and leisure. It provides immersive experiences that change how people engage with digital settings. The potential of VR to recreate realistic scenarios represents a new paradigm in interactive media.

Despite the growing popularity of VR, there is still a significant research vacuum regarding its impact on social interaction, physical activity, and user perceptions. This group is digitally adept and at a critical social and physical growth period. The precise effects of VR in various areas and how people perceive these effects remain unknown.

Given the expanding influence of VR technology on modern lifestyles, understanding its ramifications is crucial. The impact of VR use is especially significant for university students

Geliş tarihi/Recieved: 17.06.2023 – Kabul tarihi/Accepted: 19.09.2023 – Yayın tarihi/Published: 30.09.2023

developing long-term social networks and health behaviours. This research is critical for educators, technology developers, and policymakers to guide the responsible integration of VR in educational and leisure settings.

This study primarily focuses on exploring the multifaceted impacts of VR on social interaction and physical exercise among university students, alongside their perceptions of VR as a leisure tool. By investigating both the tangible effects on social and physical behaviours and delving into how students perceive and internalise their VR experiences, the study aims to offer a comprehensive understanding of VR's role in leisure. In light of this primary objective, the following hypotheses are put under the lens:

1. **H1**: Students exhibit predominantly positive perceptions and attitudes towards VR in leisure activities.
2. **H2**: Regular engagement with VR among university students is associated with significant changes in their social interaction patterns, potentially enhancing virtual connectivity while impacting real-world social engagements.
3. **H3**: The use of VR among university students is linked to a dual impact on physical activity levels, potentially enhancing engagement in active experiences while posing risks of reinforcing sedentary habits.

Literature Review

VR in Leisure Contexts

VR, a specialised equipment-enabled computer-generated simulation of a three-dimensional environment that can be physically or virtually interacted with, has evolved from its original utilitarian uses to become an integral part of contemporary leisure pursuits. Incorporating digital media into recreational activities represents a significant transformation in how individuals interact with it, especially college students, notorious for rapidly adopting cutting-edge technologies (Crawford, 2020).

The introduction of VR to the entertainment industry has been a paradigm shift. VR provides an unparalleled immersive experience, enabling users to interact within a completely realised three-dimensional world, according to Martín-Gutiérrez *et al.* (2017). The level of engagement exhibited by this entertainment form, which is beyond the capabilities of conventional modes, powerfully appeals to university students, who frequently seek out innovative and thought-provoking encounters. The study conducted by Nimrod and Adoni (2012) provides additional evidence that VR offers a wide range of recreational prospects, including interactive gaming that combines social interaction with entertainment and virtual tourism experiences that transcend geographical limitations.

One of the essential features of VR for recreation is its capacity for customisation. According to Crawford (2020), VR technology enables individuals to customise their leisure experiences by selecting activities and environments that correspond to their preferences and interests. This aspect of VR is desirable to college students due to its compatibility with their inclination towards customised and distinctive experiences (Nimrod & Adoni, 2012).

Increasingly, the social aspect of VR in leisure is acknowledged as a crucial element. As Anderson and Silk *et al.* (2016) emphasised, VR facilitates novel social interaction and community development modes. VR gaming, for instance, provides an innovative platform for

social engagement by extending the experience beyond individual play to include participation in virtual interactions with others. This aspect holds significant importance for college students, as it is fundamental to their academic and social existence that they establish and sustain social connections (Bayram, 2022).

Despite the increasing fervour surrounding VR for recreational purposes, apprehensions persist regarding its potential long-term ramifications. Silk *et al.* (2016) and Sivan (2020) highlight the potential concerns that may arise from an excessive dependence on virtual environments for recreational purposes. These concerns include reduced involvement with the tangible world and authentic social exchanges.

Perceptions and Attitudes Towards VR

A substantial body of literature indicates that VR is generally well-received by the general populace. According to a study by Leung (2020), individuals frequently perceive VR as a groundbreaking and innovative technology, with its immersive and interactive attributes particularly appealing. Evans *et al.* (2021) indicate that VR promotes collaborative experiences and social interaction. Moreover, a study conducted by Shen *et al.* (2022) underscores the potential of VR in academic environments, specifically by simulating authentic situations to augment learning and involvement.

Although there is considerable enthusiasm for using VR, concerns are associated with its implementation. According to Gallace and Girondini (2022), specific individuals harbour concerns about VR, precisely the possibility of social isolation and the dependence on virtual interactions instead of in-person connections. Physical adverse effects of VR, including discomfort and motion sickness, are subjects of considerable concern, according to a study by Bayram (2022).

Diverse perspectives on VR exist, influenced by personal encounters and the nature of the VR material. Attitudes towards VR are notably impacted by personal experience with technology and the calibre of VR encounters, according to Siani and Marley (2021). VR experiences with limited exposure or substandard content tend to elicit more unfavourable reactions, while those with engaging, high-quality content elicit more positive reactions.

Related Hypothesis

The study hypothesises that individuals exhibit predominantly positive perceptions and attitudes towards VR in leisure activities.

Impact of VR on Social Interaction

Incorporating VR into the fabric of social interaction, particularly among university students, marks a paradigm change in interpersonal dynamics. The emergence of VR has introduced innovative social environments that transcend geographical constraints (Atsiz, 2021). The study conducted by Shen and Wall (2021) analyses how VR environments facilitate social interaction by allowing users to surpass conventional social limitations, including geographical restrictions. VR has emerged as a medium through which various social networks are established and maintained, particularly in academic environments where the investigation of cutting-edge technologies is prevalent. Furthermore, Hutson (2022) emphasises the capacity of

social VR applications to facilitate cultural exchanges, collaborative projects, and virtual gatherings, thereby expanding social engagement beyond physical campuses.

The investigation of how VR can improve social skills and empathy has been the subject of recent research. Amichai-Hamburger and Etgar (2018) demonstrate how incorporating VR simulations into university curricula can foster empathy and comprehension by engaging students in otherwise inaccessible, realistic scenarios. Further, Riner *et al.* (2022) propose that immersive experiences of this nature have the potential to substantially foster the growth of interpersonal aptitude and emotional intelligence, both of which are fundamental elements in facilitating social interaction.

Amidst VR's numerous advantages to social interaction, a substantial counterargument arises regarding social isolation. Concerns are expressed by Gallace and Girondini (2022) concerning the immersive qualities of VR, which, although captivating, could potentially result in disengagement from social interactions in the physical world.

VR's impact on preexisting social relationships embodies a multifaceted interplay. According to Yalon-Chamovitz and Weiss (2008), although VR provides novel methods for preserving and strengthening long-distance relationships, it may also neglect immediate social interactions. The contradiction above highlights the complex interplay between VR technology and the social fabric, specifically among college students who must navigate virtual and physical social environments.

Related Hypothesis

Regular engagement with VR among university students is associated with significant changes in their social interaction patterns, potentially enhancing virtual connectivity while impacting real-world social engagements.

VR and Physical Activity

The correlation between VR and physical activity, specifically in the context of higher education institutions, constitutes an intricate and diverse field of research. The emergence of VR has disrupted conventional beliefs that digital leisure is primarily inactive. A significant change is evident in how VR promotes engaging and active physical experiences (Gao & Lee, 2019). Thorough investigations by Kavanagh *et al.* (2020) and Brimelow *et al.* (2020) demonstrate that immersive VR applications, specifically those engineered for athletics and fitness, can substantially increase physical activity levels.

VR technology has applications that surpass mundane entertainment, including fitness training and physical rehabilitation. Empirical research conducted by Campo-Prieto *et al.* (2022) provides further evidence of VR's positive impact on physical therapy outcomes. VR, through the creation of simulated and controlled environments, not only enhances the efficacy of therapeutic exercises but also sustains patient motivation and engagement, particularly among university students and young adults. Moreover, Hartstein *et al.* (2022) emphasise the individualised exercise regimens and rehabilitation programmes that VR technology provides. These programmes are gaining popularity among university athletes and students needing physical rehabilitation as they facilitate more effective and efficient recovery.

Despite these positive developments, the passive nature of many VR experiences is becoming an increasing source of concern. Bayram (2022) explores this paradox by examining how specific VR applications, notwithstanding their immersive allure, necessitate minimal physical exertion and may unintentionally promote extended periods of inactivity. This matter holds particular significance for collegiate populations, who may exhibit a heightened propensity for sedentary behaviours due to scholarly obligations and personal preferences. The cumulative influence of VR on physical activity levels is significantly influenced by the characteristics of VR content and the decisions users make during their VR experiences (Yalon-Chamovitz & Weiss, 2008; Yeh *et al.*, 2019).

VR is portrayed in the literature as having two sides to physical activity. College students must balance participating in immersive VR experiences and upholding a physically active and healthful way of life. Siani and Marley (2021) underscore the significance of moderation and consciousness regarding utilising VR among this demographic. They espouse adopting a well-rounded strategy that capitalises on the advantages of VR in encouraging physical activity while concurrently addressing the potential hazards linked to heightened sedentary behaviour.

Related Hypothesis

VR usage among university students is linked to a dual impact on physical activity levels, potentially enhancing engagement in active experiences while posing risks of reinforcing sedentary habits.

Theoretical Conceptual Framework

This research is framed within an intricate theoretical conceptual matrix, drawing from diverse disciplines such as media studies, psychology, and information technology. This multifaceted framework is designed to dissect and elucidate the complex dynamics of VR in social interaction, physical activity, and user perception, particularly emphasising its integration into leisure activities.

At the heart of this framework lies the 'Uses and Gratifications Theory', a cornerstone in communication research. This theory provides a nuanced understanding of why individuals gravitate towards specific media platforms, including VR (Ball *et al.*, 2021). Within the VR context, this theory sheds light on the myriad motivations propelling its use, ranging from the pursuit of entertainment to the need for social connectedness and escapism. It enables exploration into how users' intrinsic needs and preferences shape their interactions with VR technology and how these interactions, in turn, fulfil distinct gratifications (Musa *et al.*, 2015; Ruggiero, 2017).

'Bandura's Social Cognitive Theory' serves as another pivotal component of this framework, offering insights into the behavioural ramifications of VR engagement. Through the emphasis on observational learning and behavioural modelling principles, this theory elucidates how users assimilate and adapt social and physical behaviours within VR settings (Imam & Jarus, 2014). It provides a critical lens through which the influence of VR on real-life social competencies and physical activity patterns can be assessed, considering the medium's immersive and interactive potential (Koutroubas & Galanakis, 2022; Chen, 2024).

Mihaly Csikszentmihalyi's concept of 'Flow' is critical in understanding user engagement and immersion, particularly within VR experiences. Flow is a state of complete immersion and

absorption in an activity, characterised by a loss of sense of time, heightened focus, and enjoyment. This state is often achieved during activities that perfectly balance the challenge with the individual's skill level (Nakamura & Csikszentmihalyi, 2002). In the realm of VR, the theory of Flow is particularly relevant due to VR's unique ability to create highly engaging and immersive environments. VR experiences, which can be challenging and skill-enhancing, offer an ideal platform for users to experience flow states. This theory will be employed to analyse how VR facilitates deep engagement and affects users' experiences, potentially enhancing both their social and physical interactions in leisure activities (Beard, 2015).

The 'Technology Acceptance Model' further augmented the framework, which provides a foundational understanding of how perceptions of usability and utility influence the acceptance and integration of technology, such as VR (Sagnier *et al.*, 2020). This model is particularly pertinent in examining how perceptions of VR's ease of use and its perceived benefits influence its adoption in leisure contexts and subsequently affect social and physical behaviour patterns (Fussell & Truong, 2022).

With its interdisciplinary approach, this theoretical conceptual framework offers a robust scaffold for the study. It amalgamates theories from psychology, media studies, and technology acceptance, creating a rich tapestry that captures the diverse nature of VR's impact on modern leisure. It sets the groundwork for a comprehensive exploration of how VR reshapes social interactions, influences physical activities, and moulds user perceptions.

Research Gap

In the swiftly progressing field of VR, scholarly endeavours have extensively probed its technological evolution, psychological ramifications, and diverse applications spanning the educational, healthcare, and entertainment spheres. Nevertheless, amidst this academic proliferation, a pronounced research lacuna persists in fully deciphering VR's complex repercussions, especially within the leisure milieu. An incisive scrutiny of existing scholarship uncovers that, although investigations have touched upon VR's modulation of social comportment and physical exertion, these inquisitions frequently skim the surface, particularly in leisure contexts. Specifically, the subtle details underpinning how habitual VR engagement recalibrates the fabric and profundity of social interplay in leisurely environments remain underexplored. This void extends into physical activity, marked by a shortage of comprehensive research dissecting the dichotomy between VR-induced active involvement and sedentariness.

Hence, this study is poised to traverse these uncharted territories, methodically unravelling the involved ways VR sculpts social dynamics, sways levels of physical activity, and shapes user perceptions within leisure landscapes. Its objective is to unfurl empirical revelations that transcend the prevailing comprehension of VR's utility, illuminating its expansive ramifications in leisurely pursuits. In bridging these scholarly chasms, the research is envisioned to make a substantive and eloquent contribution to the dialogues in media studies, psychology, and leisure sciences. It endeavours to augment academic understanding of VR's role in contemporary leisure and proffer tangible insights for developers, educators, and policymakers aiming to refine the deployment of VR technologies.

MATERIALS AND METHODS

Research Design

In this study, an explanatory cross-sectional survey design is adopted to systematically elucidate the correlations between the use of VR in leisure scenarios and its subsequent impacts on social interaction and physical activity dynamics. This design, a cornerstone within quantitative research methodologies, is selected for its robust capacity in empirical hypothesis testing (Omair, 2015; Bloomfield & Fisher, 2019). Consequently, this study strategically focuses on unravelling the current trends and interrelationships inherent in VR engagement within leisure contexts.

Participants

The study recruits a diverse sample of 657 participants through a stratified random sampling technique to capture a representative cross-section of young adults engaged in VR activities within leisure contexts. The participant pool predominantly consists of young adults, with ages ranging from 18 to 27 years. This age group is deliberately selected as it represents the demographic most actively engaged in VR for leisure and is likely to experience significant impacts of the technology in terms of social interaction and physical activity. The sample is carefully balanced in gender, comprising 348 females and 309 males. This gender diversity is integral to the study, allowing for exploring potential gender-based differences in VR usage and its effects. Furthermore, participants are drawn from various university levels, including undergraduates, postgraduates, and various academic majors. **Table 1** below presents the sample's characteristics.

Table 1. Characteristics of the Sample

Variables		Frequency	Percentage
Gender	Male	309	47%
	Female	348	53%
	Total	657	100%
Frequency of VR Use	Always	145	22%
	Often	220	33%
	Sometimes	182	28%
	Rarely	85	13%
	Never	25	4%
Total		657	100%

Instrument

In this research, a sophisticatedly designed structured questionnaire is employed as the primary tool for data collection, it is methodically formulated to capture an extensive array of data crucial for elucidating the multifaceted impact of VR on social interaction, physical activity, and user perceptions. This instrument is divided into two parts, ensuring a comprehensive aggregation of demographic information alongside specific attitudinal and behavioural insights pertinent to VR engagement.

The initial segment of the questionnaire is dedicated to collating fundamental demographic data from the participants, including age, gender, and the frequency of VR usage. This segment plays a pivotal role in creating an accurate demographic profile of the respondents, thereby facilitating an incisive analysis that accounts for demographic variations, which could significantly inform the study's outcomes. The demographic data serves as the cornerstone for a nuanced understanding of the study's participant base, providing a lens through which the subsequent findings can be precisely interpreted.

Progressing to the second segment, the questionnaire intensifies its focus, branching into three crafted factors, each comprising ten items. These factors are strategically developed to resonate with the study's central themes and hypotheses. The first factor orbits around the perceptions and attitudes of users towards VR in leisure, offering an in-depth exploration of their viewpoints on VR's advantages, drawbacks, and overall value in leisure settings. The second factor probes into VR's influence on social interaction, examining how much VR usage modulates social behaviours and experiences. The third factor delves into the interplay between VR engagement and physical activity, evaluating whether VR usage promotes a more active lifestyle or perpetuates sedentary habits. The 30 items were scored on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The negative-worded statements were coded reversely before the mean calculations were conducted. Higher mean scores revealed: higher levels of positive perceptions and attitudes towards virtual reality in leisure, higher levels of social interaction, and higher levels of physical activity.

Data Collection

The data collection phase of this research was orchestrated over three months, spanning from February to May 2023, at Northern Border University, Saudi Arabia. This period was judiciously chosen to comprehensively ascertain the impact of VR on leisure among university students. A key strategy in reaching this demographic involved utilizing an academic network, wherein university teachers played an instrumental role. By distributing the survey link directly to their students, these educators facilitated a focused and efficient reach to the intended participants. They imbued the research with heightened credibility and trust, fostering a more responsive and engaged participant base. During the data collection timeframe, sustaining participant engagement and securing an adequate response rate were paramount.

Data Analysis

This study utilised the Statistical Package for the Social Sciences (SPSS). The initial analysis stage involved deploying descriptive statistical techniques, such as calculating frequencies and percentages. The Pearson correlation coefficient was employed to delve deeper into the nature of the relationships among the various study variables. A critical aspect of the study involved evaluating the internal consistency of the questionnaire, for which Cronbach's Alpha was calculated. Exploratory Factor Analysis (EFA), a technique pivotal in identifying and interpreting latent variables and underlying structures within the dataset, was conducted in parallel. To complement the analysis performed with SPSS, the LISREL statistical package was explicitly utilised to conduct Confirmatory Factor Analysis (CFA).

RESULTS AND DISCUSSION

Pilot Study

In order to validate the accuracy and appropriateness of the questionnaire items for the target sample, a preliminary pilot study was conducted with a sample size of 50 individuals. This crucial step was undertaken to confirm the overall validity and reliability of the study's instrument before its final implementation. The pilot study focused on establishing the face validity of the instrument, ensuring that the questionnaire was comprehensible and relevant to the participants. Subsequently, a comprehensive application of both exploratory and confirmatory factor analysis techniques was employed.

Starting from face validity, commonly called the validity of judges, the research underwent a comprehensive evaluative process facilitated by a panel of seasoned experts. This panel methodically examined the questionnaire, emphasising its precision in capturing and quantifying the intended constructs. The insights provided by these experts were pivotal in refining the instrument's efficacy and relevance. Their feedback encompassed a series of recommendations, including modifying specific terminology to enhance clarity, eliminating redundant or non-contributory items, and incorporating new items to address previously overlooked dimensions.

In order to assess the internal consistency validity of the study's instrument, an in-depth analysis was conducted focusing on the coherence among individual items and their respective dimensions, as well as the overall alignment of these dimensions with the scale's aggregate score. This assessment involved the meticulous calculation of correlation coefficients for each item relative to the total score of its corresponding dimension and, similarly, for each item concerning the overall scale score. The analysis revealed that all items demonstrated a significant positive correlation, each exceeding the threshold of 0.50, thereby justifying their retention in the scale. These findings, indicative of robust internal consistency within the instrument, are detailed in **Table 2**, presenting a comprehensive view of the inter-item and item-to-scale correlations.

Table 2. Correlation Coefficients Between Statement Scores and Corresponding Dimension Totals in the Questionnaire

General Perceptions and Attitudes Towards VR in Leisure			Social Interaction			Physical Activity		
No	dimension	Scale	No	dimension	scale	No	dimension	Scale
1	.835**	.703**	1	.791**	.755**	1	.642**	.642**
2	.801**	.800**	2	.780**	.680**	2	.813**	.813**
3	.844**	.749**	3	.824**	.756**	3	.805**	.805**
4	.794**	.768**	4	.814**	.727**	4	.751**	.751**
5	.758**	.712**	5	.860**	.689**	5	.856**	.856**
6	.777**	.724**	6	.816**	.784**	6	.833**	.833**
7	.851**	.731**	7	.705**	.692**	7	.642**	.642**
8	.873**	.815**	8	.742**	.741**	8	.813**	.813**

9	.856**	.793**	9	.826**	.789**	9	.759**	.681**
10	.793**	.773**	10	.880**	.727**	10	.677**	.686**

Table 2 presents data showing that the correlation coefficients are notably high and achieve statistical significance at the alpha level 0.01. This finding underscores a robust internal coherence within each dimension of the study's instrument and the respective items associated with these dimensions. Such results indicate the questionnaire's robust validity, affirming its effectiveness and appropriateness in accurately measuring the intended constructs.

To check the scale's construct validity, an evaluation was conducted by calculating the correlation coefficients between the aggregated scores of each dimension and the overall score of the questionnaire. This methodological step was vital for determining the extent of alignment between individual dimensions and the total instrument score, thus providing a substantive measure of construct validity. The detailed results of this evaluation, crucial for verifying the scale's effectiveness in accurately measuring its designated constructs, are methodically outlined in **Table 3**.

Table 3. Correlation Coefficients between each Factor Score and Total Scale Score

Factors	Attitudes Towards VR in Leisure	Social Interaction	Physical Activity	Scale
Attitudes Towards VR in Leisure	1	.802	.632	.902
Social Interaction		1	.663	.918
Physical Activity			1	.861

As indicated in **Table 3**, the analysis reveals that the correlation coefficients among the various dimensions are notably high, with values spanning from 0.632 to 0.802. This trend of strong correlations is also observed between each dimension and the scale's total score, where the coefficients lie in the range of 0.861 to 0.918. These correlations are statistically significant at the 0.01 significance level, underscoring the robust interconnectivity within the scale's dimensions and their collective alignment with the overall scale measurement.

The factor validity of the scale was thoroughly evaluated through a two-step analytical process. Exploratory Factor Analysis (EFA) initially used the Principal Components method to discern the underlying factor structure. This involved the application of orthogonal rotation via the Varimax method, facilitating the identification of the most relevant items for each factor based on their saturation levels. Items that exhibited saturations exceeding 0.4 were meticulously selected and attributed to the factor where they demonstrated the highest saturation, acknowledging that certain items showed high saturations on multiple factors. This analysis extracted three distinct factors, with 30 items displaying significant saturation across these factors. The collective variance accounted for by these factors was 54.559%, with the first factor comprising ten items and an eigenvalue of 6.618, explaining 22.061% of the total variance. The second factor included ten items, with an eigenvalue of 5.991, contributing to 19.971% of the total variance. The third factor, encompassing ten items with an eigenvalue of 3.758, accounted for 12.527% of the total variance.

Subsequently, to further validate and confirm the item saturation for each factor, Confirmatory Factor Analysis (CFA) was conducted utilising the Maximum Likelihood Method in conjunction with the LISREL program. This confirmatory step corroborated the three-factor structure initially identified in the EFA. Path coefficients for the scale items ranged from 0.42 to 0.94, all demonstrating statistical significance at the P≤0.01 level. Furthermore, the chi-square ($\chi 2$) value stood at 617.42 with 160 degrees of freedom at a significance level of P≤0.001, indicating a $\chi 2/df$ ratio of 3.86 and signifying a robust model fit. Goodness-of-fit indices, including RMSEA, GFI, AGFI, and NFI, were within optimal ranges, reinforcing the suitability of the proposed model to the dataset and affirming the scale's factor validity. **Figure 1** provides a visual representation of the scale's confirmatory factor structure.

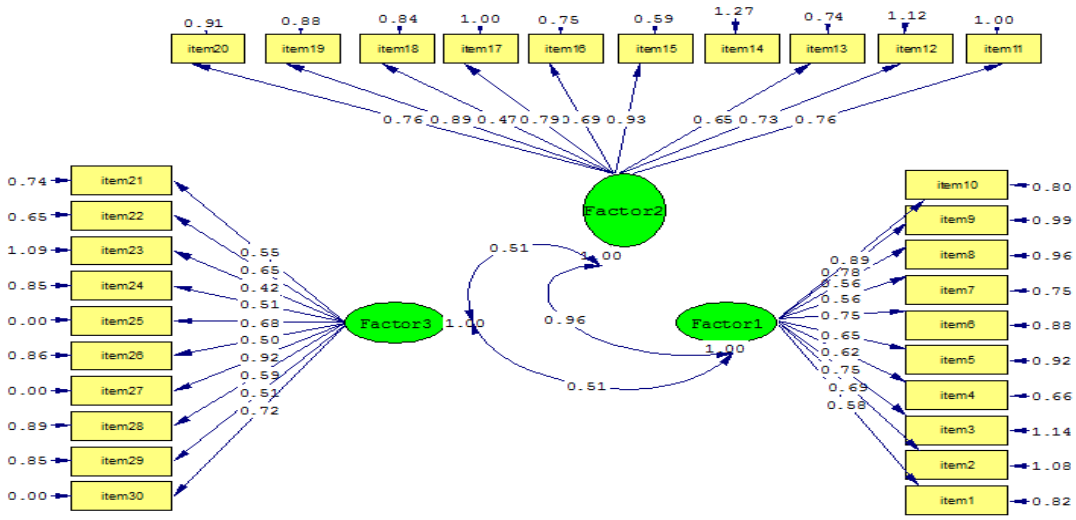

Figure 1. A Visual Representation of the Scale's Confirmatory Factor Analysis.

An in-depth analysis was conducted as part of the CFA to assess the scale's Convergent Validity and Composite Reliability. This analysis involved applying specialised equations to calculate the scale's Composite Reliability (CR) and the Average Variance Extracted (AVE). These metrics are critical in determining the reliability and validity of the constructs within the scale. The outcomes of this rigorous statistical evaluation, which provide a quantitative measure of the scale's reliability and the adequacy of the variance captured by the model, are detailed in **Table 4**.

Table 4. Composite Reliability and Convergent Validity Values for the Scale.

Factors	No. of items	Cronbach's Alpha (α)	Composite Reliability(CR)	AVE
Attitudes Towards VR in Leisure	10	0.835	0.880	0.594
Social Interaction	10	0.721	0.809	0.570

Physical Activity	10	0.773	0.839	0.523
Total	30	0.922	0.948	0.631

Main Study Findings

This section begins with analysing the frequency of VR use among participants, calculated through frequencies and percentages. The resulting data, pivotal for gauging the extent of VR engagement in the sample, is detailed in the following figure.

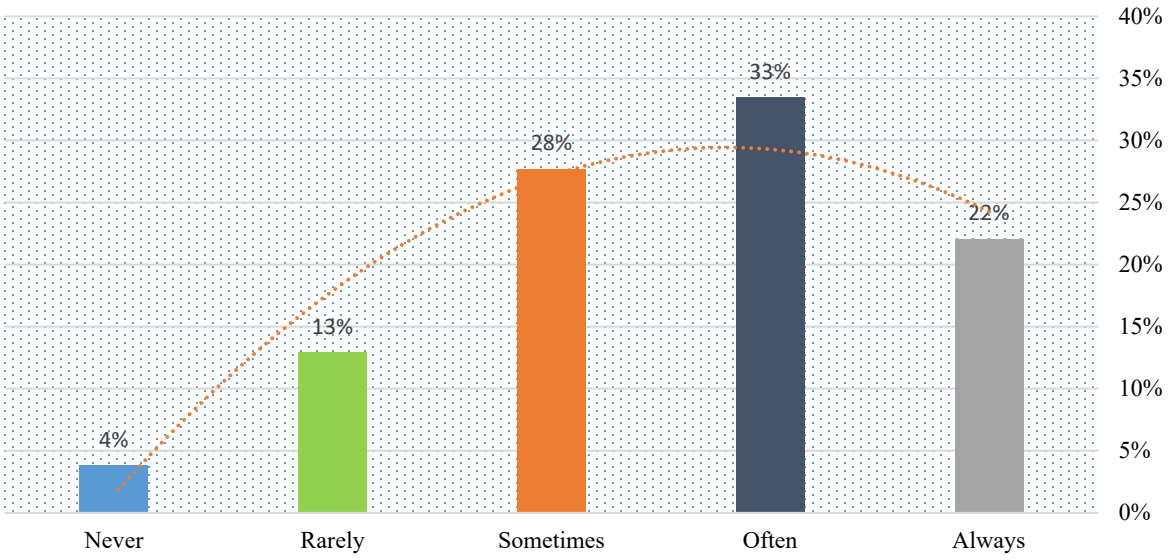

Figure 2. The Frequency of VR Use Among Participants.

The data presented in the **Figure 2** indicates a notable inclination towards frequent VR usage among the study's participants. 33% of respondents reported using VR 'Often,' complemented by 28% who engage with VR 'Sometimes.' Furthermore, 22% of the participants fall into the 'Always' category, underscoring a consistent and regular interaction with VR. In contrast, a smaller segment of 13% reported 'Rarely' using VR, and a minimal 4% indicated they 'Never' engage with VR technology. These findings highlight a prevalent trend of VR engagement, with most participants demonstrating at least occasional usage, pointing towards VR's significant role in their digital interaction spectrum.

Hypothesis Testing

Table 5. T-Test Results for Hypotheses

H1: VR Users' Positive Perceptions.							
Sample size	**Mean**	**Std**	**Assumed mean**	**df**	**t**	**sig**	**Result**
657	35.72	7.50	30	656	19.538	0.000	Statistically significant
H2: Social Interaction Patterns in VR Usage.							

Sample size	Mean	Std	Assumed mean	df	t	sig	Result
657	34.77	7.98	30	656	15.315	0.000	Statistically significant
H3: The Influence of VR Usage On Physical Activity							
Sample size	Mean	Std	Assumed mean	df	t	sig	Result
657	36.05	8.18	30	656	18.951	0.000	Statistically significant

H1: It is hypothesised that individuals who frequently engage in VR for leisure activities hold predominantly positive perceptions and attitudes towards VR's role in leisure.

To empirically validate this hypothesis, a One-Sample T-test was employed. The analysis revealed that the average response score for the sample on the first dimension of the questionnaire, addressing General Perceptions and Attitudes Towards VR in Leisure, stood at 35.72, with a standard deviation of 7.50. This was measured against a hypothetical mean value of 30 for the scale. The comparison demonstrated that the sample's mean score surpassed the scale's hypothesis. Further, the statistical significance of this deviation was confirmed, as evidenced by a t-value of 19.538, which notably exceeds the critical t-value at 656 degrees of freedom. This significant result is delineated in **Table 5**, substantiating the hypothesis and highlighting regular VR users' positive perceptions and attitudes in leisure contexts.

The analysis results substantiate the hypothesis that individuals engaging frequently in VR for leisure purposes exhibit predominantly positive perceptions and attitudes towards its role in leisure activities. This conclusion aligns with the statistically significant findings indicating a favourable disposition among regular VR users towards its utility in leisure contexts.

H2: Regular engagement with VR among university students is associated with significant changes in their social interaction patterns, potentially enhancing virtual connectivity while impacting real-world social engagements.

A One-Sample T-test was applied to evaluate Hypothesis H2, which posits that regular VR usage among university students correlates with notable shifts in their social interaction patterns. The analysis revealed that the average response score on the questionnaire's social interaction' dimension was 34.77, with a standard deviation of 7.98, against a theoretical mean of 30. This comparison demonstrated that the actual mean for the sample on the aspect of Social Interaction significantly exceeded the scale's hypothetical mean. The statistical testing of these differences confirmed their significance at the 0.01 level, evidenced by a computed t-value of 15.315, which surpasses the critical value at 656 degrees of freedom, as detailed in **Table 5**. This result substantiates the hypothesis, indicating a significant relationship between regular VR engagement and alterations in social interaction patterns among university students.

The empirical findings corroborate Hypothesis H2, asserting that regular engagement with VR among university students correlates with substantial alterations in their patterns of social interaction. The statistical significance of these results underscores a discernible transformation in virtual connectivity and real-world social interactions attributable to habitual VR usage. This data distinctly illustrates a linkage between steady VR engagement and

modifications in social behaviour, thereby validating the underlying assertion of Hypothesis H2.

H3: The use of VR among university students is linked to a dual impact on physical activity levels, potentially enhancing engagement in active experiences while posing risks of reinforcing sedentary habits.

In examining Hypothesis H3, which posits a dual impact of VR use on physical activity levels among university students, a One-Sample T-test was employed for validation. The analysis of responses in the questionnaire's 'Physical Activity' domain yielded a mean score of 36.05 with a standard deviation of 8.18, against a predetermined theoretical mean of 30. This comparison highlighted that the actual mean of responses exceeded the theoretical benchmark, suggesting a significant deviation. Upon assessing the statistical significance of these differences, it was confirmed at a 0.01 significance level. The computed t-value of 18.951 notably surpassed the threshold t-value for 656 degrees of freedom, indicating a substantial variance from the hypothesised mean. These findings, detailed in **Table 5**, provide empirical support for Hypothesis H3, illustrating the complex influence of VR usage on physical activity among university students.

The analytical outcomes support Hypothesis H3, indicating that VR usage among university students exerts a bidirectional effect on their physical activity levels. This influence manifests as both an augmentation in active engagement and a possible increase in sedentary behaviour. The statistical data, validated through the One-Sample T-test, reveal significant variances in physical activity patterns attributed to VR engagement. These results decisively illustrate that consistent use of VR among this demographic is associated with marked shifts in physical activity, thus validating the dual-impact hypothesis outlined in H3.

The findings regarding Hypothesis H1 have unequivocally proven that consistent users of VR for leisure purposes have an overwhelmingly favourable perception and attitude towards its function as a medium for recreation. This disclosure is noteworthy within the increasing incorporation of VR into leisure domains. The substantial statistical evidence supporting this hypothesis demonstrates a clear pattern: Individuals who routinely incorporate VR into their leisure activities positively perceive its effectiveness and utility in enhancing leisure experiences.

These positive perceptions have numerous underlying causes. One notable aspect is VR technology's interactive and immersive nature, which sets it apart from conventional recreational pursuits. VR provides users with an unparalleled form of amusement, enabling them to engage with and perceive digital realms in manners that are unattainable through traditional media. This may result in increased levels of engagement and enjoyment. Moreover, the continuous development of VR, characterised by increased availability and a more comprehensive range of potential uses, has undeniably been instrumental in moulding these favourable perspectives. With the increasing accessibility and integration of VR technologies into a diverse range of leisurely activities (e.g., virtual tourism and gaming), they are increasingly recognised and embraced as a captivating and mainstream element of leisure time. The increasing recognition and pleasure stem from the novelty of VR, which tends to draw in individuals searching for novel and inventive recreational opportunities.

By situating these findings within the framework of current scholarly works, a cohesive story emerges consistent with previous studies that emphasise the positive reception of VR in leisure environments. Research has consistently demonstrated that immersive technologies, such as VR, significantly enhance the recreational experience by providing novel and captivating options for time spent in leisure (Leung, 2020; Evans *et al.*, 2021). The results of this research support these observations, shedding light on an emerging pattern in which users rapidly embrace digital advancements, particularly in the recreation domain. This contradicts certain studies that suggest a more apprehensive or reluctant attitude towards adopting novel technologies for recreational purposes. Instead, these studies suggest a shift in culture and behaviour that encourages individuals to embrace digital advancements in their leisure activities. As a result, these findings contribute to the current body of knowledge concerning VR as a tool for leisure and emphasise a more inclusive and receptive attitude towards contemporary technologies in the realm of leisure.

The empirical evaluation of Hypothesis H2 reveals that frequent usage of VR for leisure significantly alters social interaction patterns among university students. This fundamental discovery highlights VR's transformative role as a leisure medium, significantly influencing young adults' social dynamics. The study finds explicitly that regular VR use in leisure augments virtual social connectivity and tangibly affects interactions in the real world.

The genesis of these shifts in social behaviour is rooted in VR's immersive and engaging qualities as a leisure tool. VR provides an unparalleled platform for social engagement within virtual settings, diverging significantly from conventional leisure activities. For university students, typically early adopters of emerging technologies, VR offers an innovative and attractive avenue for socialisation. While VR enriches leisure experiences with unique social encounters, it concurrently may instigate a paradigm shift in traditional social interaction modalities. The allure and diversity of social experiences within VR could shift preferences towards virtual interactions, potentially impacting the frequency and nature of face-to-face social engagements.

When contextualised against the backdrop of existing literature, these findings elucidate a nuanced interplay between digital leisure activities and social conduct. Prior research has been divided over the impact of digital technologies on social interaction, with some studies suggesting a supplementary effect to traditional socialising and others indicating a potential decline in physical and social engagements (Amichai-Hamburger & Etgar, 2018; Gallace & Girondini, 2022; Riner *et al.*, 2022). This study adds depth to this discourse, illustrating that VR, as a tool in leisure, exercises a dualistic influence on social interactions among university students, simultaneously enriching virtual socialisation while potentially reconfiguring or diminishing conventional social interactions. This revelation is pivotal in comprehending the more enormous ramifications of embedding immersive technologies like VR in leisure activities, particularly among the youth. It underscores the necessity for a balanced integration of VR in leisure, harmonising its groundbreaking social potential with the sustenance of traditional social interaction forms. The insights gleaned from these findings deepen the understanding of VR's role in leisure and provide valuable implications for future research and practical implementations in leisure and technological innovation.

Examining Hypothesis H3 has conclusively demonstrated that utilising VR in leisure activities among university students has a bifurcated impact on their physical activity levels. This dual

effect is critical in leisure, where VR can potentially augment active engagement in physical experiences while posing a risk of promoting sedentary behaviour. This finding is pivotal in understanding VR's complex role within the sphere of leisure and its influence on physical activity among young adults in an educational setting.

The diversity in VR applications, especially within leisure contexts, explains these contrasting effects. Active VR experiences, such as interactive games and simulations that require physical movement, contribute positively by incorporating physical activity into leisure time in a novel and engaging ways. However, many VR leisure activities, particularly those that are more passive or gaming-oriented, involve minimal physical movement, contributing to a sedentary lifestyle. This dichotomy in VR's impact on physical activity in leisure underscores its multifaceted nature: VR can foster active participation in leisure activities, yet it also has the potential to encourage sedentary behaviours depending on the type of leisure activity and user engagement.

This study's insights resonate with and add to existing research on digital technology's impact on physical activity within leisure. Prior studies have shown diverse effects, with some highlighting the positive role of interactive technologies in enhancing physical activity in leisure (Campo-Prieto *et al.*, 2022; Hartstein *et al.*, 2022), while others suggest that increased engagement with digital leisure activities can lead to more sedentary behaviours (Yeh *et al.*, 2019; Bayram, 2022). This study extends this narrative by specifically highlighting VR's dual role in leisure – as a facilitator of physically active and sedentary experiences.

Limitations and Recommendations for Further Research

This study, delving into the impacts of VR in leisure, identifies several fundamental limitations, each pointing toward valuable directions for future research. While effective for immediate assessment, the cross-sectional design limits the analysis to a specific timeframe and hinders the exploration of causal relationships or long-term trends. Future studies could adopt longitudinal designs to capture the evolving impacts of VR over time. Furthermore, though insightful, the focus on a university student demographic restricts the generalizability of the findings. Expanding future research to include a more diverse range of participants would enhance the applicability of the results. The reliance on self-reported data via a structured questionnaire may also introduce biases and constrain the depth of analysis. Future research could benefit from incorporating mixed-methods approaches, utilising qualitative techniques like interviews or focus groups to enrich the understanding of VR's role in leisure. Addressing these limitations will broaden the research scope and deepen the comprehension of VR's multifaceted influence in leisure contexts.

CONCLUSION

This study examines the varied effects of VR on university students, particularly emphasizing its function in leisure activities. The findings provide a detailed look at how VR, as a rising leisure tool, affects this generation's social connections, physical exercise, and overall perceptions. Empirical evidence supports the hypotheses that VR usage influences perceptions and attitudes towards leisure activities, alters social interaction patterns, and has a dual effect

on physical activity levels, increasing engagement in active experiences while posing risks of reinforcing sedentary habits. These findings are critical for grasping the broader implications of adopting VR into leisure contexts, particularly for young adults in academic settings. The study emphasizes the importance of taking a balanced approach to VR use in leisure, highlighting its potential to enhance leisure activities and pointing out potential drawbacks. It emphasizes the necessity of developing VR content and applications that engage and benefit users' social and physical well-being. Furthermore, the research contributes to the theoretical foundations of leisure studies, social interaction, and physical activity, urging these frameworks to be updated to account for the complications offered by immersive technology such as VR. The findings provide practical advice for incorporating VR into educational and recreational programmes, proposing tactics that maximise VR's benefits while limiting its hazards. The study paves the way for future research into the long-term effects of VR on the social and physical components of leisure and the development of interventions that maximise VR's positive impact. Finally, the research demonstrates the revolutionary potential of VR in leisure, providing vital insights for its effective integration into university students' and the larger community's leisure activities.

ACKNOWLEDGMENTS: None

CONFLICT OF INTEREST: None

FINANCIAL SUPPORT: None

ETHICS STATEMENT: This study was conducted in compliance with ethical guidelines and received approval from the relevant Ethics Committee. Participants were clearly informed about the research objectives and provided their participation based on informed consent. All data was treated with the utmost confidentiality and respect for participant privacy.

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