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Perceived enjoyment and peer influence on adoption of virtual reality in higher education

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ABSTRACT

Virtual reality (VR) exhibits substantial educational potential, but its adoption rate among Chinese students in higher education institutions remains low, with a lack of empirical research on influencing mechanisms, especially in regions like Nantong. This study constructed a model based on the unified technology acceptance and use theory 2 (UTAUT2), and collected 402 sample data from students of Nantong higher education institutions. An empirical study was conducted using the structural equation model (SEM). The results showed that perceived enjoyment (intrinsic motivation) and peer influence (extrinsic motivation) were positively correlated with the willingness to use VR and the adoption of VR. The willingness to use played a partial mediating role. This study innovatively proposed the synergistic driving effect of intrinsic motivation and extrinsic motivation in the context of higher education in China, and provided practical guidance for the promotion of VR in higher education.

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1. INTRODUCTION

Virtual reality (VR) can provide students with an immersive learning experience and has become an emerging technology in the field of education [1]. VR is a powerful technology for national educational innovation. It can overcome the limitations of traditional face-to-face learning, reduce the resource constraints on students' practical operation, improve students' learning experience, and inject new vitality into higher education [2]. With the gradual improvement of VR teaching resources and the iterative update of hardware facilities, VR has gradually become an important way for higher education institutions to digitally transform education [3].

Although VR education has great potential, the adoption rate of VR is still not ideal, and there are still many challenges in promoting VR. During the use of VR devices, some users will feel dizzy and other physical discomfort, which will reduce their willingness to use VR [4]. Users pay great attention to the comfort, interactivity and realism of the virtual environment [5]. In addition, some students in higher education institutions are skeptical of VR, and the surrounding environment, especially the influence of peers, has an important impact on whether students use VR [6]. The widespread application of VR also depends on factors such as infrastructure, personal perception, and willingness to use, among which personal perception and willingness to use are key factors [7]. Nantong is a representative city of education in China, and higher education in Nantong is undergoing digital transformation. VR is being introduced into more and more higher education institutions, but there are still many problems in the adoption of VR [8]. This study is

based on an empirical study of the willingness and adoption of VR by students in higher education institutions in Nantong, China, thereby filling a gap in this field and promoting the widespread promotion and application of VR in higher education.

2. LITERATURE REVIEW AND HYPOTHESES

2.1. The unified theory of acceptance and use of technology 2 (UTAUT2)

This study is based on the UTAUT2, a theoretical model used to explain the factors influencing users' intention to use technology and actual use, which includes perceived pleasure as one of the influencing factors [9]. Compared with the original UTAUT model, UTAUT2 emphasizes users' emotional experiences and intrinsic motivations during the technology usage process, making it more suitable for exploring the adoption of immersive educational technologies such as VR [10], [11]. UTAUT2 model confirms that behavioral intention directly affects actual usage behavior, and this conclusion has been verified in multiple educational and technological environments [12].

UTAUT2 has been widely applied in the research on educational technology adoption, but recent international studies have pointed out its research gaps in the context of immersive technology and cross-cultural education [13]. In metaverse-based learning research, the synergy between intrinsic and extrinsic motivations in driving VR adoption has not been fully explored in the UTAUT2 framework, and the model lacks targeted analysis of the emotional and social characteristics of metaverse-integrated VR learning [14].

2.2. Intrinsic motivational factor

Perceived enjoyment is defined as the degree to which an activity involving the use of VR is considered pleasant beyond any possible expected performance consequences [15], and it represents an intrinsic motivation where an individual is willing to continue using the technology because of the pleasure experienced during the process. As a core intrinsic motivation, perceived enjoyment has been confirmed to have a positive impact on the actual usage behavior of virtual learning environments: the higher the degree of perceived enjoyment, the greater the possibility that students will accept virtual technology [16]. Previous studies have found that perceived enjoyment has a significant positive impact on the adoption of virtual reality in architecture and urban planning education, and the pleasure brought by immersive experiences is one of the main motivations for the adoption of virtual reality in education [17], and this factor has also been verified to have a significant impact on user behavior in 3D virtual websites and mobile social media websites [18].

In the VR education scenario, the immersive and interactive features of VR can enhance learners' pleasure and participation, thereby increasing their intention to use it [19] , and it is worth noting that if people find a new technology enjoyable, beneficial and pleasant, they are more likely to adopt it. Recent international research on metaverse-based VR learning has further expanded this finding [20]. However, existing studies mostly focus on the separate exploration of perceived enjoyment's impact on VR usage intention or actual adoption, and the internal logical link between the two has not been fully clarified.

2.3. Extrinsic motivational factor

Peer influence refers to the degree to which learners perceive that their social groups (such as peers, friends, and classmates) expect or do not expect them to use virtual reality technology, that is, whether individuals are subject to social pressure generated by the expectations of others [21]. As an important component of social influence in the UTAUT2 model, peer influence plays a particularly prominent role in the university student group. In educational settings, students are often influenced by the opinions of their peers, especially when it comes to emerging technologies: if peers actively adopt a certain technology, other students are more likely to be driven by the imitation effect and the herd mentality, thereby increasing the possibility of adoption [22].

Many learners are sensitive and concerned about the opinions of their peers, so the mutual influence among learners needs to be emphasized in the learning and use of virtual reality technology [23]. The positive and subjective evaluations of VR by the surrounding group and its useful evaluations tend to enhance learners' intention to use VR, while negative functional evaluations of VR by the surrounding may weaken learners' tendency and interest to try using VR [24]. Students often judge the value and applicability of technology by observing the behaviors and attitudes of their peers, thereby forming their own usage intentions [25]. Cross-cultural international studies have confirmed that in collectivist cultural contexts represented by China, peer influence has a more significant driving effect on the adoption of educational technology compared with Western individualist cultures, as group norms and social conformity are important factors affecting college students' decision-making [26], yet few studies have systematically explored the impact of peer influence on Chinese college students' VR usage intention and actual adoption behavior.

2.4. The dual role of intention to use VR

The individual behavioral intention regarding the use of information technology can reasonably explain future technological usage [27], and a large number of domestic and foreign researchers have regarded "use intention" as an important predictor variable for predicting whether users will actually adopt a certain technology [28]. Studies have shown that the more an individual is subjectively inclined to use a certain technology, the higher the possibility of taking practical actions [29], and the behavioral intention to use VR is an important and significant determinant for students to adopt VR learning [30].

In addition to its direct predictive role on VR adoption, behavioral intention also plays an important indirect mediating role in influencing technology adoption through multiple variables [31], [32]. In the field of virtual tourism, users' intention to use plays a significant mediating role between performance expectations, enjoyment motivation, habits and actual visits to historical sites [33].

2.5. Research hypotheses

Based on the above systematic synthesis and analysis of existing literature, the following research hypotheses are proposed:

- H1: There is a relationship between perceived enjoyment and students' adoption of virtual reality.
- H2: There is a relationship between peer influence and students' adoption of VR.
- H3: There is a relationship between perceived enjoyment and students' intention to use VR.
- H4: There is a relationship between peer influence and students' intention to use VR.
- H5: There is a relationship between students' intention to use VR and students' adoption of VR.
- H6: Students' intention to use VR mediates the relationship between perceived enjoyment and students' adoption of VR.
- H7: Students' intention to use VR mediates the relationship between peer influence and students' adoption of VR.

The conceptual framework of the study constructed based on the above hypotheses is shown in Figure 1.

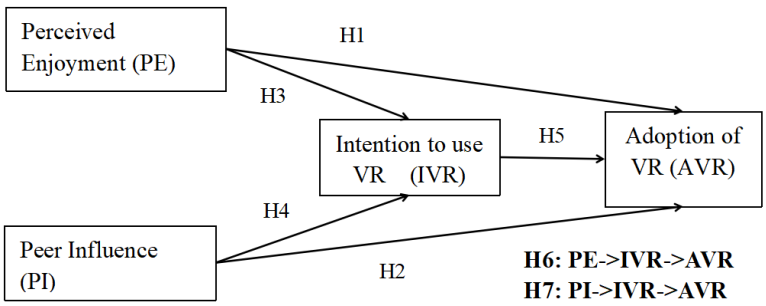

Figure 1. Conceptual framework

3. METHOD

3.1. Sample and data collection

The research scope covered all full-time students (grades 1 to 4) from 9 higher education institutions in Nantong City, including those with and without virtual reality experience. This study employed stratified random sampling to conduct proportional sampling of students from nine higher education institutions in Nantong. Questionnaires were distributed to students at these institutions through the online platform "Wenjuanxing". The questionnaires were structured scales, and a total of 512 questionnaires were collected. After removing invalid data, 402 valid questionnaires were obtained. In the sample, males accounted for 53.5% and females for 46.5%. Students from Nantong University accounted for 19.4% of the sample, and students from Nantong University of Science and Technology accounted for 17.4%. By year, third-year students accounted for 44.3%, first-year students for 28.9%, second-year students for 17.4%, and fourth-year students for 9.5%. By major, students majoring in computer-related fields accounted for 70.9%. Regarding VR experience, 50.5% of the respondents had relevant experience.

3.2. Constructs measurement

The constructs to be measured in this study include perceived enjoyment, peer influence, VR usage intention, and VR adoption. The questionnaire designed for this study contains the respondents' personal

information and items related to the four constructs. All the items of the constructs in this study are adapted from existing relevant references. Specifically, all the items of perceived enjoyment are derived from existing research and have been empirically validated in a non-Western educational context. All the items of peer influence are also derived from existing research and have been cross-culturally modified in the context of Chinese higher education. The items of VR usage intention and VR adoption are based on the UTAUT2 theoretical model and relevant empirical studies in the context of Chinese higher education. The formal questionnaire adopts a 5-point Likert scale (1=Strongly Disagree, 5=Strongly Agree). Perceived enjoyment (PE) measures students' internal pleasure in using technology, with 4 items. Peer Influence (PI) measures peer, classmate and friend influence on individuals' technology use, with 4 items. Intention to use VR (IVR) measures students' VR use intention, with 7 items. adoption of VR (AVR) measures students' VR adoption, with 6 items.

3.3. Descriptive statistics

This descriptive analysis was conducted using SPSS software, analyzing the minimum, maximum, average, standard deviation, skewness, and kurtosis of each item. The results showed that the absolute values of skewness and kurtosis for all data in this study were within the standard range, and the sample data followed a normal distribution. The average value of this concept for each indicator used to measure the "Perceived Enjoyment" concept was 3.76, with a standard deviation of 0.964. The average value of this concept for each indicator used to measure the "Peer Influence" concept was 3.775, with a standard deviation of 0.857. The average value of this concept for each indicator used to measure the "Intention to use VR" concept was 3.779, with a standard deviation of 0.879. The average value of this concept for each indicator used to measure the "Adoption of VR" concept was 3.727, with a standard deviation of 0.944. The results indicated that the respondents' scores on each measurement dimension were concentrated at the medium to high levels, and the overall fluctuations were moderate.

4. RESULTS

4.1. Common method variance

Common method variance (CMV) refers to irrelevant variance from the measurement method, while common method bias (CMB) is the systematic bias caused by CMV. To reduce CMB, this study used anonymous questionnaires and informed participants of the expected completion time. In the empirical stage, Harman's single-factor test showed that the first factor explained 44.021% (<50%) as shown in Table 1, indicating no serious CMB. As shown in Table 2, a common latent factor (CLF) test in AMOS showed minimal model fit changes ($\Delta\chi^2/df = 0.107$, $\Delta CFI = 0.004$, $\Delta RMSEA = 0.005$), confirming negligible CMV. Multicollinearity diagnostics indicated all VIF values <5 and tolerance >0.1, suggesting no severe multicollinearit.

Table 1. Total variance explained (n=402)

Component	Initial eigenvalues			Extraction sums of squared loadings		
	Total	Variance (%)	Cumulative (%)	Total	Variance (%)	Cumulative (%)
1	9.244	44.021	44.021	9.244	44.021	44.021
2	2.280	10.857	54.878	2.280	10.857	54.878
3	2.192	10.440	65.318	2.192	10.440	65.318
4	2.030	9.668	74.987	2.030	9.668	74.987

Table 2. Common method bias test results (N=402)

Compared models	ChiSq/df	CFI	RMSEA
Original model	1.381	0.989	0.031
Model with CMV factor	1.274	0.993	0.026

4.2. Measurement model

The measurement model was evaluated using SPSS and AMOS as shown in Table 3. Reliability analysis showed that Cronbach's alpha and composite reliability (CR) values for all latent variables exceeded 0.7, indicating good internal consistency. Convergent validity was supported as average variance extracted (AVE) values were above 0.5 and all standardized factor loadings exceeded 0.6. Confirmatory factor analysis (CFA) demonstrated good model fit ($\chi^2/df = 1.381 < 3$, $CFI = 0.989 > 0.9$, $RMSEA = 0.031 < 0.08$). Discriminant validity, assessed via the Fornell-Larcker criterion, was confirmed as the square root of each AVE exceeded its correlations with other constructs as shown in Table 4.

Table 3. Reliability and validity

Constructs	Items	Loading >0.6	Alpha >0.7	CR >0.7	AVE >0.5
Perceived enjoyment (PE)	PE1	0.852	0.895	0.898	0.689
	PE2	0.809			
	PE3	0.773			
	PE4	0.882			
Peer influence (PI)	PI1	0.929	0.919	0.919	0.741
	PI2	0.793			
	PI3	0.816			
	PI4	0.898			
Intention to use VR (IVR)	IVR1	0.85	0.925	0.927	0.648
	IVR2	0.786			
	IVR3	0.705			
	IVR4	0.768			
	IVR5	0.769			
	IVR6	0.806			
	IVR7	0.93			
Adoption of VR (AVR)	AVR1	0.916	0.932	0.936	0.712
	AVR2	0.685			
	AVR3	0.791			
	AVR4	0.878			
	AVR5	0.854			
	AVR6	0.915			

Table 4. Fornell-Larcker criterion

	PE	PI	IVR	AVR
PE	0.830			
PI	0.576	0.861		
IVR	0.653	0.746	0.805	
AVR	0.609	0.663	0.737	0.844

4.3. Structural equation modelling (SEM) results

SEM was employed to empirically test the proposed hypotheses, and the results are shown in Tables 5-7. Perceived enjoyment significantly and positively affected the adoption of VR ($\beta = 0.200$, CR = 3.862, $p < 0.001$), as did peer influence ($\beta = 0.194$, CR = 3.998, $p < 0.001$). Both variables also significantly influenced the mediating variable, intention to use VR, with coefficients of 0.386 (CR = 7.376, $p < 0.001$) and 0.285 (CR = 5.705, $p < 0.001$), respectively. Intention to Use VR had a significant positive impact on adoption of VR ($\beta = 0.388$, CR = 7.191, $p < 0.001$). The mediating effects were confirmed using 5,000 bootstrap resamples. For H6, the indirect effect was 0.237 ($p = 0.000$) and the direct effect 0.256 ($p = 0.001$). For H7, the indirect effect was 0.199 ($p = 0.000$) and the direct effect 0.199 ($p = 0.000$), with all confidence intervals excluding zero, indicating partial mediation in both cases. Figure 2 presents the standardized coefficients and significance levels for each path in the model.

Table 5. Results of H1 to H5

Hypothesis	Path	S.T.D.(β)	C.R.	p	Results
H1	Perceived enjoyment→Adoption of VR	0.2	3.862	***	Supported
H2	Peer influence→Adoption of VR	0.194	3.998	***	Supported
H3	Perceived enjoyment→Intention to use VR	0.386	7.376	***	Supported
H4	Peer influence→Intention to use VR	0.285	5.705	***	Supported
H5	Intention to use VR→Adoption of VR	0.388	7.191	***	Supported

Table 6. Results of H6

Path relationship	Point estimate	Product of coefficient		Bootstrapping					
				Bias-corrected			Percentile		
		SE	Z	Lower	Upper	P	Lower	Upper	P
Indirect effects									
PE→IVR→AVR	0.237	0.042	5.643	0.163	0.330	0.000	0.163	0.330	0.000
Direct effects									
PE→AVR	0.256	0.063	4.063	0.132	0.378	0.001	0.132	0.378	0.001
Total effects									
	0.493	0.065	7.585	0.368	0.622	0.000	0.368	0.622	0.000

Table 7. Results of H7

Path relationship	Point estimate	Product of coefficient		Bootstrapping					
				Bias-corrected			Percentile		
		SE	Z	Lower	Upper	P	Lower	Upper	P
Indirect effects									
PI→IVR→AVR	0.199	0.037	5.378	0.136	0.282	0.000	0.130	0.275	0.000
Direct effects									
PI→AVR	0.231	0.048	4.813	0.137	0.328	0.000	0.137	0.328	0.000
Total effects									
	0.431	0.054	7.981	0.326	0.542	0.000	0.322	0.540	0.000

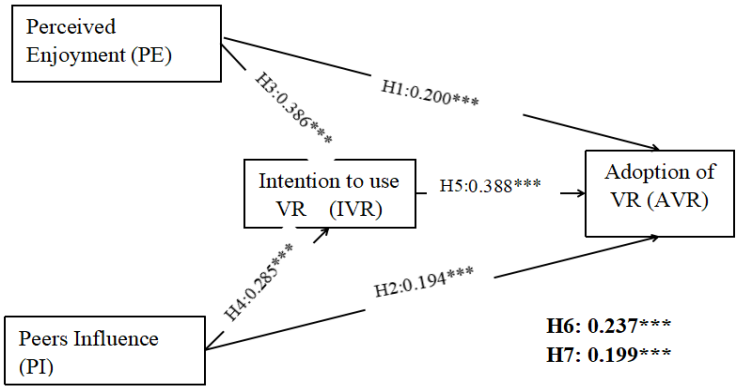

Figure 2. Structural equation modeling results

5. DISCUSSION

This study examined the influence of perceived enjoyment and peer influence on students' adoption of VR. Results showed that perceived enjoyment was positively correlated with VR adoption (H1 supported), as it confirms the positive effect on virtual learning environment acceptance and identifies immersive pleasure as a core motivation for VR adoption in architecture education. This discovery reflects the positive impact of the intrinsic factor of perceived enjoyment on the adoption of VR. VR developers need to pay attention to users' feelings, and teachers in higher education institutions need to build good VR teaching resources to enable students to learn happily in an immersive way. In addition, peer influence is also positively correlated with the adoption of VR (H2 supported), which confirms the positive impact of peer influence in social influence on the acceptance of virtual learning environments and also demonstrates cross-cultural consistency.

The research results show that perceived enjoyment and peer influence have a positive impact on the willingness to use VR (H3 and H4 are supported), which is consistent with UTAUT2. The willingness to use VR has a positive impact on VR adoption (H5 is supported). The willingness to use VR plays a partial mediating role between perceived enjoyment, peer influence and VR adoption (H6 and H7 are supported). This finding is in line with the UTAUT2 theory and empirically verifies the mediating role of technology usage intention between antecedent variables and behavior in the context of higher education in China.

In the context of higher education in China, the influence of peer influence on the willingness to use VR and the adoption of VR is more significant compared to that in individual-oriented Western countries. This is because Chinese higher education students have a stronger sense of collectivism, making them more susceptible to peer influence. Additionally, in the Chinese context, students' perception of enjoyment in VR is associated with national policy support. The relatively well-developed education system in China provides the necessary conditions for promoting this intrinsic motivation of perception of enjoyment.

This study has several limitations. The sample data for this study were collected from nine higher education institutions in Nantong. Although Nantong is one of the representative cities in China's education sector, it may still lack universal applicability. In the future, it can be expanded to different regions and countries. The conceptual framework of this study mainly focuses on the four constructs of the UTAUT2 model: perceived enjoyment, peer influence, usage intention, and VR adoption. In the future, more variables such as convenience conditions and performance expectations can be included. This study mainly measures the related constructs through structured scales. In the future, it can also be measured through various forms such as interviews.

6. CONCLUSION

Based on the UTAUT2 theory, this study empirically explored the mechanism of perceived enjoyment and peer influence on students' adoption of VR in higher education institutions. The research found that perceived enjoyment, as an internal motivation, significantly promoted students' VR adoption behavior, and peer influence, as an external social factor, also played a positive role; at the same time, the intention to use not only directly affected students' actual adoption behavior, but also played a partial mediating effect between the above variables and the adoption behavior. The research results enriched the theoretical system of educational technology adoption and provided practical references for higher education institutions to promote VR teaching applications.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
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Md Gapar Md Johar		✓				✓		✓	✓	✓	✓	✓		
Jacquline Tham	✓		✓	✓			✓			✓	✓		✓	

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors state no conflict of interest.

DATA AVAILABILITY

Data availability is not applicable to this paper as no new data were created or analyzed in this study.

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