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A Study on the Influence of Perceived Usefulness on Actual Usage of VR among Nantong Higher Education Institutions students

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Abstract
With the continuous development of virtual reality (VR) technology in the field of education, exploring its adoption mechanism in colleges and universities has significant practical significance. Based on the Technology Acceptance Model (TAM), this study constructs a structural model containing three variables: Perceived Useful, Usage Intention of VR, and Actual Usage of VR. And an empirical analysis was conducted through a questionnaire survey of students in higher education institutions in Nantong, Jiangsu Province (N=402). The research results show that Perceived Useful has a significant positive impact on both Usage Intention of VR and Actual Usage of VR, and Usage Intention plays a partial mediating role in the relationship between the two. Through the verification of the structural equation model and the Bootstrap method to test the mediating effect, this study theoretically enriches the application of the TAM model in the field of VR education and provides practical inspiration for universities to promote the application of VR teaching.
Keywords: *Perceived Useful, Usage Intention of VR, Actual Usage of VR, TAM, VR education*

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I. INTRODUCTION

Virtual reality technology is a technique capable of simulating virtual environments and providing immersive experiences [1]. In recent years, with the rapid development of virtual reality technology, it has been widely applied in various fields, including the education sector[2]. Higher education is a crucial stage for talent cultivation and knowledge dissemination. Virtual reality technology has brought new possibilities to higher education[3]. With the characteristic of transcending time and space, virtual reality technology breaks through the limitations of traditional classrooms[4]. Students can visit places that are geographically inaccessible, such as foreign museums and historical sites, through virtual reality technology to achieve virtual tourism and cultural experiences[5]. Additionally, virtual reality technology can simulate virtual laboratories and work scenarios, allowing students to conduct practical experiments in a safe and hazard-free environment, thereby enhancing their practical operation skills[6]. In recent years, China has vigorously promoted the digitalization of education and actively implemented policies such as "Intelligent+Education" and "Virtual Simulation Experimental Teaching", providing a favorable policy and technological environment for the application of VR technology in higher education[7]. Against this backdrop, many higher education institutions in China have successively established virtual reality laboratories and virtual simulation teaching centers, and VR courses have gradually been piloted and promoted in some professional fields. Currently, the utilization rate of virtual reality technology in education is relatively low, and the usage of VR education platforms does not match the expectations of learners[8]. Nantong City, as an important educational city in Jiangsu Province, has also made active explorations in response to the national call for educational informatization[9]. However, according to existing research results, the actual usage of VR in Nantong's higher education institutions is still not satisfactory[10]. Although some institutions have equipped relevant VR teaching facilities and launched pilot courses, students' active usage frequency of VR technology is relatively low, and the technology adoption rate needs to be improved. Preliminary research has found that whether students are willing to use VR is not only constrained by technical conditions but is also closely related to their subjective cognition.

II. LITERATURE REVIEW AND RESEARCH HYPOTHESES

2.1. Perceived useful and usage intention of VR

Perceived Usefulness is a core variable in the Technology Acceptance Model (TAM), referring to the degree to which an individual believes a certain technology can effectively assist them in enhancing their learning or work performance[11]. In educational settings, perceived usefulness is specifically manifested as learners' belief that virtual reality technology can help them complete learning tasks, improve comprehension, or achieve learning goals [12].

Empirical research found that perceived usefulness has a significant positive impact on college students' behavioral intention to use virtual reality technology [13]. This finding is consistent with previous research results, indicating that perceived usefulness is an important psychological driver influencing individuals' willingness to adopt technology [14]. Moreover, perceived usefulness not only affects users' behavioral intentions but also further promotes their actual usage behavior through these intentions [15]. Based on this, H1 was put forward:

H1: There is a correlation between perceived useful and students' usage intention of VR.

2.1. Perceived useful and Actual usage of VR

Previous studies have widely confirmed that perceived usefulness plays a significant role in students' adoption of virtual reality technology[16]. In the context of interior design education, perceived usefulness is regarded as the key factor driving students to use VR technology [17]. In an empirical study of Malaysian university students, it was also found that perceived usefulness significantly promoted their actual use of the virtual learning environment [18]. Moreover, the application of virtual reality in disciplines such as architecture and urban planning has shown good results, with students generally believing that this technology can enhance their understanding of course content and learning outcomes [19].

Furthermore, multiple studies have established and verified the positive relationship between perceived usefulness and technology adoption behavior, indicating that users' perception of the usefulness of the technology is an important antecedent variable influencing their actual usage behavior [20][21],[22]. Based on this, H2 was put forward:

H2: There is a correlation between perceived useful and students' actual usage of VR.

2.3 Usage Intention and Actual usage

According to the theoretical framework of the Technology Acceptance Model (TAM) and its subsequent extended models, once individuals form positive perceptions of a technology (such as perceived usefulness), if they develop clear usage intentions, they are more likely to put these intentions into practice in real situations[23],[24]. In the educational application of virtual reality technology, numerous studies have confirmed that usage intention has a significant positive impact on actual usage behavior[25][26],[27]. After students experience or understand VR technology, if they develop a positive intention to use it, they tend to actively participate in VR-related courses or activities, thereby increasing the frequency and depth of actual usage[28],[29]. Therefore, usage intention not only reflects students' acceptance attitude towards the technology but also largely determines their future usage behavior. Based on this, H3 was put forward:

H3. There is a correlation between students' usage intention of VR and students' actual usage of VR.

2.4 Mediating effect of Usage Intention

Previous studies have shown that perceived usefulness not only directly affects the actual use of technology, but also may indirectly influence behavioral performance by enhancing individuals' intention to use [30],[31]. In the context of higher education, if students realize that virtual reality technology is significantly beneficial to the learning process, they are more likely to form clear intentions to use it and ultimately exhibit higher frequency of actual usage behavior[32]. Based on this, H4 was put forward:

H4: Usage Intention of VR mediates the relationship between perceived useful and students' actual usage of VR.

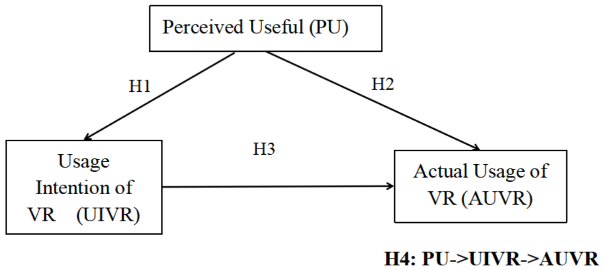

Fig. 1. Conceptual framework.

III. Methodology

3.1 SAMPLE AND DATA COLLECTION

This study took the students currently enrolled in 9 higher education institutions in Nantong City, Jiangsu Province, China as the research subjects and collected data through questionnaire surveys. The survey content covers the demographic characteristics of the respondents, their experiences of using virtual reality (VR), and related research variables [33],[34]. The questionnaires were distributed online to ensure the diversity and representativeness of the sample sources [35]. A total of 420 questionnaires were collected and 319 valid questionnaires were obtained after screening. From the point of sample distribution, male 53.0%, female 47.0%. The sample covered nine higher education institutions. The proportion of junior students was the highest (46.1%), followed by freshmen (28.5%). In terms of professional categories, students majoring in computer-related fields account for 71.5%. In terms of VR usage experience, 52.4% of the respondents said they had used it, while the remaining 47.6% had never come into contact with it.

3.2 CONSTRUCTS MEASUREMENT

This study covers three main variables, namely Perceived Useful (PU), Usage Intention of VR (UIVR), and Actual Usage of VR (AUVR). The questionnaire consists of two parts, namely the demographic information of the respondents and the relevant items used to measure the research variables.

All scales adopt the five-point Likert scale, with ratings ranging from "strongly disagree" to "strongly agree", from 1 to 5. PU is mainly used to assess whether students believe that VR technology can enhance learning efficiency, complete tasks, and achieve learning goals, with 4 items for measurement. UIVR is used to measure students' future intention to use VR for learning, including 7 items. AUVR reflects the situation of students' actual use of VR technology in learning, with 6 items set to collect relevant data.

IV. RESULTS

4.1 MEASUREMENT MODEL

To ensure the measurement quality of the research constructs, this study first evaluated the reliability and convergent validity. According to the results in Table 1, the standardized factor loadings of all measurement items were greater than 0.7, indicating that each item had good indicator representativeness [36]. The Cronbach's Alpha coefficients of all constructs were higher than 0.8, the composite reliability (CR) exceeded 0.9, and the average variance extracted (AVE) was higher than 0.7, demonstrating good internal consistency and convergent validity. Therefore, the measurement tools used in this study performed well in terms of reliability and convergent validity, providing a solid foundation for further analysis [37].

In addition, this study used the Fornell-Larcker criterion to test the discriminant validity of each construct, as shown in Table 2. The square roots of the AVE of each latent variable were greater than the correlation coefficients between them and other variables, indicating that the constructs were clearly distinguishable and had good discriminant validity [38]. In summary, the measurement model as a whole has good reliability and validity and can be used for subsequent path analysis of the structural model.

Table 1: Reliability and validity.

Constructs	Items	Loading	Alpha	CR	AVE
Perceived Useful（PU）	PU1	0.947	0.884	0.935	0.782
	PU2	0.800			
	PU3	0.862			
	PU4	0.921			
Usage Intention of VR（UIVR）	UIVR1	0.874	0.934	0.951	0.737
	UIVR2	0.854			
	UIVR3	0.795			
	UIVR4	0.801			
	UIVR5	0.827			
	UIVR6	0.891			
	UIVR7	0.958			

Actual Usage of VR（AUVR）	AUVR1	0.949	0.932	0.963	0.814
	AUVR2	0.791			
	AUVR3	0.856			
	AUVR4	0.921			
	AUVR5	0.920			
	AUVR6	0.963			

Table 2: Fornell-Larcker criterion.

	Perceived Useful（PU）	Usage Intention of VR（UIVR）	Actual Usage of VR（AUVR）
Perceived Useful（PU）	0.884		
Usage Intention of VR（UIVR）	0.658	0.859	
Actual Usage of VR（AUVR）	0.761	0.672	0.902

Model fit refers to the statistical assessment of the degree of matching between the theoretical model established and the actual data[39]. The better the fit, the more the model can reasonably explain the data structure. There are some indicators and recommended values for judging model fit[40]. The chi-square degrees of freedom ratio, ChiSq/df, generally requires to be less than 3[41]. The fit index GFI requires to be greater than 0.9. The comparative fit index CFI requires to be greater than 0.9[42]. The standard fit index NFI requires to be greater than 0.9[43]. The incremental fit index IFI requires to be greater than 0.9. The root mean square error of approximation requires to be less than 0.08[44]. The fit indices of the measurement model in this study are shown in Table 3. All indicators meet the requirements, indicating that the model has a strong structural validity.

Table 3: Goodness-of-fit indices for model.

Model	ChiSq/df	GFI	CFI	NFI	IFI	RMSEA
Research model	1.773	0.936	0.979	0.953	0.979	0.049
Qualified request	<3	>0.9	>0.9	>0.9	>0.9	<0.08

4.2 STRUCTURAL EQUATION MODELLING RESULTS (SEM)

This study employed SEM technology to empirically verify the proposed hypotheses. The specific analysis results are presented in Table 4 and 5. The research findings indicate that perceived usefulness has a significant positive impact on the mediating variable "Usage Intention of VR", with a β value of 0.485 and a p-value less than 0.001. Hypothesis H1 was accepted. Further analysis revealed a significant positive correlation between Perceived Useful and Actual Usage of VR. The β value for this path was 0.342, and the p-value was less than 0.001, indicating that hypothesis H2 was accepted. At the same time, the effect of Usage Intention of VR on Actual Usage of VR was also significant, with a β value of 0.343 and a p-value also less than 0.001, indicating that hypothesis H3 was accepted.

This study used the Bootstrap method for 1000 runs and obtained the percentile level values and bias-corrected confidence intervals at a 95% confidence level. As shown in Table 5, the mediating effect of the path PU→UIVR→AUVR was 0.174, and 0 was not within the confidence interval range, indicating that the mediating effect was effective. The direct effect of PU→AUVR was 0.358, and 0 was not within the upper and lower limits of the confidence interval, indicating that the direct effect was also effective. Therefore, the Usage Intention of VR of students played a partial mediating role in perceived usefulness and students' actual use of VR. The β values and significance of each path are marked in Figure 2.

Table 4: Results of Mode Hypothesis of Direct Relationships.

Hypothesis	Path	S.T.D.(β)	C.R.	p	Results
H1	Perceived Useful→Usage Intention of VR	0.485	8.355	***	Supported
H2	Perceived Useful→Actual Usage of VR	0.342	5.753	***	Supported
H3	Usage Intention of VR→Actual Usage of VR	0.343	5.842	***	Supported

Table 5: Bootstrap Mediating Effect Testing.

Path relationship	Point estimate	Product of coefficient		Bootstrapping					
				Bias-corrected			Percentile		
		SE	Z	Lower	Upper	P	Lower	Upper	P
Indirect Effects									
PU→UIVR→AUVR	0.174	0.039	4.462	0.108	0.257	0.001	0.105	0.251	0.002
Direct Effects									
PU→AUVR	0.358	0.067	5.343	0.227	0.486	0.002	0.227	0.487	0.002
Total Effects									
	0.531	0.066	8.045	0.384	0.652	0.003	0.392	0.658	0.002

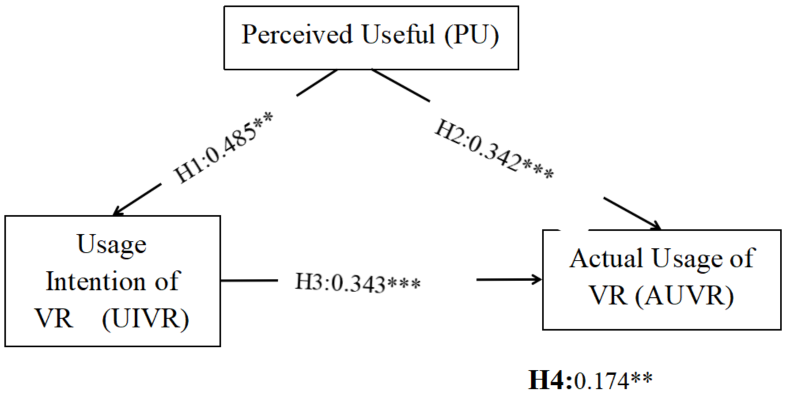

Fig. 2. SEM results.

V. Discussion

The research results verified the proposed hypothesis model. In the higher education environment, Perceived Usefulness has a significant positive impact on the Actual Usage of VR, and also significantly influences the Usage Intention of VR. Further analysis revealed that the Usage Intention of VR also has a significant effect on the Actual Usage of VR. The mediation effect test indicated that the Usage Intention of VR played a partial mediating role between Perceived Usefulness and Actual Usage of VR. These findings suggest that students' actual usage of VR is not only directly influenced by their perceived benefits but also indirectly driven by their usage intentions, thereby supporting the theoretical path constructed in this study.

VI. Conclusion

This study is based on TAM and constructs a structural equation model including Perceived Useful, Usage Intention of VR and Actual Usage of VR, to explore the mechanism of higher education students' adoption of virtual reality technology. Through the empirical analysis of questionnaire data, the study verifies that Perceived Useful not only directly affects Actual Usage of VR, but also plays a partial mediating role through Usage Intention of VR. The results show that the perceived usefulness plays a key role in promoting students' actual use of VR, while usage intention is an important mediating variable affecting the final behavior. This study deepens the understanding of the adoption mechanism of virtual reality technology in the education field and provides a feasible empirical basis and decision-making suggestions for universities to carry out VR teaching.

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