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Behavioral Intention and Use Behavior of University Students in Chengdu in Using Virtual Reality Technology for Learning

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Abstract

The purpose of this study is to investigate the factors that influence the usage of virtual reality (VR) technology in learning among university students in Chengdu, China. Scholars created a virtual reality teaching game based on Unreal Engine 4 software that was utilized to instruct a videography course at the Design College of Sichuan University of Media and Communications in Chengdu, China, with 1160 university students participating in a two-year pedagogical reform project. The researchers employed a quantitative research approach with a sample size of 50 participants, as well as a face-to-face questionnaire survey of the target respondents. The data was gathered via stratified random sampling. The Confirmatory Factor Analysis (CFA) and Structural Equation Model (SEM) were applied to analyze the data (SEM). The findings indicate that all factors have a substantial influence on students' utilization of virtual reality (VR) technology in learning, with behavioral intention having the biggest impact on actual usage, and that satisfaction has a considerable impact on actual usage. Research has also shown that perceived enjoyment has been confirmed to have a direct and significant impact on attitude. Attitude, perceived behavioral control, and subjective norm have indirect effects on actual system use through behavioral intention.

Keywords: Virtual Reality, Perceived Ease of Use, Perceived Enjoyment, Perceived Behavioral Control, Subjective Norm

JEL Classification Code: I21, I23, I29, O33

1. Introduction[1,2]

1.1 Background of the Study

The definition of virtual reality technology is a fully interactive, computer-based multimedia environment in which users become participants in a computer-generated realm. Researchers view virtual reality technology as one of the most innovative and influential sectors, and the VR industry has already produced advancements in a wide range of fields, including astronomy, medicine, and anthropology. Shopping, entertainment, training, and education applications are also evolving, and VR technology boasts the potential to serve as a universal platform for immersive engagement experiences across several industries (Cipresso et al., 2018; Fussell & Truong, 2021; Sattar et al., 2020). Constructivism is the superior basis for building a theory of education in a virtual world, and it holds the potential to be a strong educational tool based on the essential features of virtual reality (Pantelidis, 2010).

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The application of virtual reality technology in education is endowed with enormous potential. The utilization of virtual reality technology as a teaching aid remains in its infancy in China, particularly in higher education, with the 3 issues listed below. The first is a paucity of research in real-world educational environments due to a lack of virtual reality technologies (Jie Huang, 2019). Second, since virtual reality teaching tools lack educational material, they are used seldom and for a short amount of time, thereby failing to accurately reflect the impact of virtual reality teaching tools (Zhao & Shen, 2022). Ultimately, the majority of relevant academic studies are qualitative, resulting in a lack of studies in this sector. As technological innovation in VR devices has surged and a host of low-cost VR devices such as the Oculus Rift have entered the market, the number of VR applications has proliferated and new application scenarios have emerged. technologies such as Unity 3D and Unreal Engine 4 have eased the process of creating VR games and reduced the complexity of creating VR content (El-Wajeh et al., 2022). Chinese universities have started building virtual reality labs and have promoted research on the application of virtual reality technology in education, especially quantitative research.

1.2 Objectives of the Study

a) To examine the factors affecting actual system use of VR technology for learning among undergraduate students from Sichuan University of Media and Communications in Chengdu of China.

b) To investigate the relationship between variables that have a significant impact on actual system use of VR technology for learning.

1.3 Research Questions

a) What are the factors affecting undergraduate students from Sichuan University of Media and Communications in Chengdu of China to actual system use of VR technology for learning?

b) What is the relationship between variables that have a significant impact on actual system use of VR technology for learning?

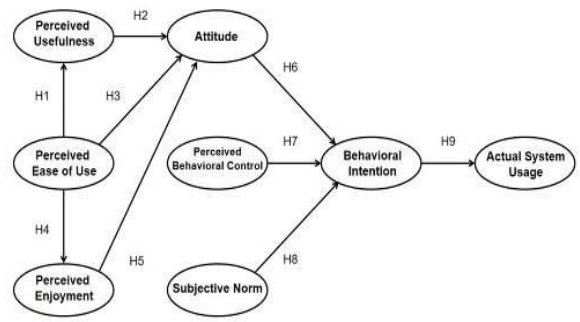

Figure 1: Conceptual Framework

1.4 Conceptual Framework

Conceptual framework developed by reviewing previous academic research frameworks and is centered on the TAM and TPB theories (see Figure 1).

1.5 Significance of the Study

Above all, by assessing the factors that influence college students' usage of virtual reality technology in learning, it provides suggestions and guidance to college instructors, as well as boosts college teachers' conviction in utilizing virtual reality technology in teaching. Furthermore, educational institutions must grasp how learners feel about using virtual reality technology in their learning in order to select suitable teaching content and scheduling, ensure effective teaching impacts, and ultimately secure student support. Finally, this study may assist colleges and institutions in setting up virtual reality laboratories and offer instructions to designers of virtual reality teaching tools

2. Literature Review

2.1 Perceived Ease of Use

Perceived ease of use refers to the degree to which a person considers that using a particular technology will be effortless (Adams et al., 1992). Davis et al. (1989) previously confirm the connection between perceptions of ease of use, perceived usefulness, and attitude.

Perceived ease of use is the determinant of perceived usefulness because the user thinks the system is more useful when it is easier, assuming other conditions are the same (Davis et al., 1992; Davis & Venkatesh, 2004; Tarmuji & Ahmad, 2019; Yi & Hwang, 2003). Perceived ease of use is directly influential on intentions and indirectly influential through perceived usefulness. Perceived ease of use is the initial barrier that users must overcome to accept, adopt and actual system usage (Venkatesh, 2000).

A study by Taylor and Todd (1995a) found a significant relationship between users' attitudes towards IT systems and IT systems, with a stronger path from ease of use to attitude for inexperienced users. Tarmuji and Ahmad (2019) used the Perceived Resource and Technology Acceptance Model (PRATAM) to determine the factors that affect students' adoption of e-learning behavior in mathematics. It is found that the perceived ease of use has a positive and direct effect on the attitude of use. This result is supported by other studies (Morris & Dillon, 1997; Rotchanakitumnuai & Speece, 2009). Perceived ease of use is directly influential on attitude and indirectly influential through perceived usefulness. Secondly, perceived ease of use is the initial barrier that users must overcome to accept, adopt and actual system usage (Venkatesh, 2000).

Within the framework of TAM, Davis et al. (1992) believe that the enjoyment of perception is similar to driving the execution of activities that are not related for any reason except for the process of executing the activity itself. Venkatesh (2000) found that over time, as users get a more direct experience of the system, the influence between enjoyment and perceived ease of use becomes stronger. In the construction of the VR hardware acceptance model, Manis and Danny (2019) discovered that perceived enjoyment, as a key belief variable, is an important factor influencing the use of virtual reality technologies, and perceived ease of use has been found to have the greatest impact on perceived enjoyment. And some studies support this idea that perceived ease of use affects the perceived enjoyment of a computer system or application (Igbaria et al., 1996; Suki et al., 2012).

H1: Perceived Ease of Use has a significant impact on Perceived Usefulness.

H3: Perceived Ease of Use has a significant impact on Attitude towards using VR technology in learning.

H4: Perceived Ease of Use has a significant impact on Perceived Enjoyment.

2.2 Perceived Usefulness

Perceived usefulness refers to the degree to which users reckon that adopting a specific technology would enhance their work performance. It has been identified as one of the key aspects that can impact an individual's attitude toward utilizing an information system (Davis et al., 1989). In Singapore, Teo and Noyes (2011) investigated the impact of perceived pleasure on pre-service teachers' inclination to utilize technology. Farahat (2012) found in a survey of students' intention to use online learning that perceived ease of use predicted students' attitudes toward online learning. According to the findings of the study, perceived usefulness has a considerable beneficial influence on attitude. Prior literature on the variables impacting respondents' adoption of virtual reality (VR) in the classroom revealed perceived usefulness to be a significant factor in attitudes toward VR technology use (Huang et al., 2010; van Raaij & Schepers, 2008; Syed-Abdul et al., 2019).

H2: Perceived Usefulness has a significant impact on Attitude towards using VR technology in learning.

2.3 Perceived Enjoyment

Perceived enjoyment is described as the degree to which technological activities are considered delightful in the absence of any predicted performance consequences (Teo & Noyes, 2011). Individuals will have an emotional drive to interact with a system if they find it attractive. Simply put, when people find a system enjoyable, then they are emotionally motivated to interact with that system (Hujran et al., 2020). According to the findings of the study, raising perceived enjoyment may be utilized to enhance consumer attitudes and attract customers to technological goods (Davis & Venkatesh, 2004). In a survey on intention to use AR smart glasses, researchers found that perceived enjoyment was a direct influence on attitude, even over perceived usefulness (Holdack et al., 2022). In order to evaluated learners' acceptance of the AR environment, Wojciechowski and Cellary (2013) adopted the TAM model proposed by Davis et al., (1992) which adds perceived enjoyment. Researchers found that perceived enjoyment has a significant positive impact on the attitude of AR system use.

H5: Perceived Enjoyment has a significant impact on Attitude towards using VR technology in learning.

2.4 Attitude

A personal perspective of an object, such as admiring or hating it, is characterized as an attitude. In other words, individuals are more prone to reject behaviors with which they disagree and embrace behaviors with which they agree. It expresses a person's emotions regarding the appropriateness of the activity (Al-Debei et al., 2013). According to the TRA model, beliefs drive attitudes, which lead to intentions, which result in behaviors. The more favorable the attitude towards utilizing technology, the stronger the perceived usefulness, perceived ease of use, and compatibility (Hartshorne & Ajjan, 2009). Vidanagama (2016) studied the acceptance of online learning among Sri Lankan university students and found that students' attitudes had a huge impact on the intention to use online learning. Farahat (2012) studied the determinants of students' acceptance of online learning through a survey of 153 undergraduate students using online learning at DBMU and the results showed that students' attitudes of online learning were considered as an important determinant of students' intention to practice online learning.

H6: Attitude has a significant impact on behavioral intention of using VR technology in learning.

2.5 Perceived Behavioral Control

Perceived behavioral control refers to a person's perception of his or her ability to perform a specific behavior, which is related to the concept of self-efficacy. The structure of perceived behavioral control alludes to a person's perception of how much control they possess over the execution of a behavior, which is primarily linked to the complexity of performing the behavior (Ajzen & Madden, 1986). The theory of planned conduct, which has gained substantial empirical support, effectively adds the structure of perceived behavioral control to the preceding concept of reasoned action. In following regressions of perceived behavioral control, it was demonstrated to be an independent predictor of behavioral intention (Manstead & Eekelen, 1998). Hujran et al. (2020) investigated Jordanian citizens' awareness of the concept of e-democracy and their willingness to participate in research. The results showed that perceived behavioral control had a significant effect on citizens' intention to use e-democracy. In the field of education, Altawallbeh et al. (2004) proposed a significantly positive effect of PBC on e-learning intention. Chu and Chen (2016) found a significant positive relationship between perceived behavioral control and e-learning intention in a study of e-learning technology.

H7: Perceived Behavioral Control has a significant impact on behavioral intention of using VR technology in learning.

2.6 Subjective Norm

Subjective norm is regarded as a person's opinion that is based predominantly on whether most relevant individuals to that person consider that the conduct should be regarded by that person (Ajzen & Fishbein, 1975). It also encompasses the social pressure that people sense from their surroundings while deciding whether or not to engage in a given behavior (Al-Debei et al., 2013). The behavioral intention to utilize technology is most tightly linked to subjective norm (Marcinkiewicz & Regstad, 1996). Park et al. (2012) found that the subjective norm had a significant effect on the behavioral intention to use m-learning in an investigation of the factors influencing the use of m-learning among Korean college students. Other investigations back up this point of view (Cheung & Vogel, 2013; Chiu & Wang, 2008; Hartshorne & Ajjan, 2009).

H8: Subjective norm has a significant impact on behavioral intention of using VR technology in learning.

2.7 Behavioral Intention

The expected consequence that directs the planned action is behavioral intention, which is an individual's purpose to undertake a certain action (Sivo et al., 2018). Behavioral intents are the motivations that drive and encourage consumers to engage in particular behaviors (Al-Debei et al., 2013). Alam et al. (2019) compared the influencing factors associated with the international expansion of mHealth services in two different country settings, China and Bangladesh, and found that behavioral intention was a determinant of actual system use. Behavioral intention is a predictor of actual system use, especially in the field of teaching technology, and various studies on the field of teaching technology have shown that using behavioral intention has a direct and significant impact on the use of teaching technology (Abbad et al., 2009; Al-Gahtani, 2016; Mahmodi, 2017).

H9: Behavioral intention has a significant impact on actual system use of using VR technology in learning.

3. Research Methods and Materials

3.1 Participants

In 2020-2021, with the approval of the research administration of Sichuan University of Media and Communications, the Design College of Sichuan University of Media and Communications in Chengdu, China, conducted an instructional technology reform project in which a total of 1160 students participated, and all participants gave informed written consent. All participants were design majors, and VR technology was employed in the course "Fundamentals of Camera". VR technology was used 8 times, each for 15-20 minutes, with an interval of 1 week between the 2 uses. The project was completed in 2 academic years, with a total of 612 participants in the first group completing the course from September 2020 to December 2020. The 548 participants in the second group completed the course from September 2021 to December 2021.

3.2 Apparatus

In the VR condition, MI VR glasses with a 2K resolution and a field of vision of 100 x 120 degrees were adopted. The gadget measures 201 x 107 x 91 mm and weighs 208 grams. It is equipped with a handle that enables several sorts of interaction via dials and buttons. Each participant was assigned 1 device, which provided a discrete VR learning environment. The questionnaires were paper-based and were distributed and collected in a face-to-face format after participants completed 2 learning sessions.

3.3 Learning Material

The learning materials were inspired by a real classroom example. The VR simulation is built on material extracted from an existing PowerPoint-based course and evolved into an interactive 3D environment. This topic introduces students to camera features and uses, such as shutter, aperture, focal length, and sensitivity. The previous lecture style utilized a PowerPoint presentation to demonstrate the impacts of the multiple functions displayed on screen, along with graphics to show how to alter the settings as needed for the screen. The production utilizes Unreal Engine 4, and a portion of the model was produced with 3DMAX and Blender software. Participants in the VR environment can interact with the program and explore how the different features affect the captured video.

Participants were encouraged to interact with the learning environment in order to acquire knowledge about the camera's numerous functionalities so that they could utilize the real camera in future sessions. They were given verbal instructions on how to utilize the equipment, alter the learning environment's parameters, and traverse the learning environment. Participants could navigate throughout the learning environment via the handles, and buttons were accessible to modify various camera characteristics. Since the MI VR glasses offer complete head tracking, users may freely glance at 3D items and the environment. Researchers collaborated extensively with course instructors to verify that each condition contained the identical content, material, and amount of information.

3.4 Sample Size and Sampling Technique

The target population for this academic study was undergraduate design students at the Design College of Sichuan University of Media and Communications in Chengdu. The structural equation model (SEM) A-priori sample size calculator was used to calculate the suggested minimum sample size of 444, and 460 suitable individuals were picked after filtering the data.

The researchers utilized a technique known as probability sampling. For a total of 1160 students from the Design College of Sichuan University of Media and Communications in Chengdu, China, who participated in the project and had VR learning experience. After obtaining the agreement of the academic committee, the researchers obtained the IDs of all participating students. All IDs were divided into two grades and then randomly selected by SPSS 23.0 software after being entered into the SPSS 23.0 software, a stratified random sample of 460 was selected (see Table 1).

Table 1: The Number of Questionnaires Distributed to Each Grade

Group	Number of students	Number of samples
Grade 2020	612	243
Grade 2021	548	217
Total	**1160**	**460**

Source: Constructed by the author

3.5 Survey

The survey included demographic questions such as grade and gender, in addition to items measuring the eight constructs used in this study. Perceived ease of use was measured with three items adapted from Chen Ying et al. (2015). Perceived usefulness was measured using four items from Chen Ying et al. (2015). Perceived enjoyment was measured with three items from Wojciechowski and Cellary (2013). Attitudes were measured by adapting three items from Chu and Chen (2016). Behavioral intention was measured by three items also from Chu and Chen (2016). The four items from Taylor and Todd (1995b) were adapted to measure the subjective norm. Perceived behavioral control was also measured by adapting the Taylor and Todd (1995b) scale, which contains a total of four items. Actual system usage was measured using three items that were adapted from Alam et al. (2019). All the items were scored on a five-point Likert scale, ranging from (1) strongly disagree to (5) strongly agree. Before data collection, the Index of Item-Objective Congruence (IOC) was checked by three experts with all items retaining a score of at least 0.67 (Litwin, 1995). The Cronbach's Alpha (CA) reliability test for the 30 participants showed that perceived ease of use was 0.886, perceived usefulness was 0.838, perceived enjoyment was 0.772, attitude was 0.897, behavioral intention was 0.747, subjective norm was 0.779, perceived behavioral control was 0.862, and actual system usage was 0.820. All values of 0.70 or above are acceptable (Nunnally, J. C., & Bernstein, 1994).

4. Results

4.1 Demographic Information

Freshman had a total of 243 people, accounting for 52.83%. Sophomores had a total of 217 people, accounting for 47.17%. The majority of respondents were women, accounting for 61.52%(N=283). The male respondents accounted for 38.48%(N=177).

4.2 Confirmatory Factor Analysis (CFA)

Confirmatory factor analysis (CFA) is performed to explore whether the loadings of confirmatory observed variables and the number of constructs is based on theoretical or research hypotheses. The significance of each observed variable's factor loading and the permissible values proved the research matrix's goodness of fit (Hair et al., 2006). The results of the AMOS 24.0 version were adjusted and exposed. The chi-square value to the degree of freedom (CMIN/DF) was 1.937, which is lower than 3.00 (Hair et al., 2009), the goodness-of-fit index (GFI) was 0.920, which is greater than 0.90 (Hooper et al., 2008). The adjusted goodness-of-fit index (AGFI) was 0.881, which was more than 0.85 (Schermelleh-engel et al., 2003), the normalized fit index (NFI) was 0.931, which was equal to 0.90 (Kline, 2015), the comparative fit index (CFI) was 0.953, which was over 0.90 (Hair et al., 2006), the tucker–lewis index(TLI) was 0.958, which was equal to 0.90 (Kline, 2015), and the root mean square error of approximation (RMSEA) was 0.043, which is less than 0.05 (Hu & Bentler, 1999).

All the CFA testing indications for the good of fits in this academic study were considered satisfactory. All the values of Cronbach's Alpha greater than 0.70, factor loadings more than 0.50, p-value less than 0.50, composite reliability (CR) more than 0.70, and average variance extracted (AVE) more than 0.50 (Sarmento & Costa, 2016), all the evaluates were significant (see Table 2).

When the value of CR is larger than AVE and the AVE is greater than 0.50, the convergent validity is determined (Hair et al., 2009). Likewise, the discriminant validity values evaluated and displayed exceeded the critical point values. Consequently, the convergent and discriminant validity of the research were ensured. Moreover, the matrix assessment results supported discriminant validity and validation to examine the reliability of the ensuing structural model estimation (see Table 3).

Table 2: Example of a Table Caption

Variables	Source of the Questionnaire	No. of Items	Cronbach's Alpha	Factor loading	CR	AVE
Perceived Ease of Use	(Chen Ying et al., 2015)	4	0.814	0.683-0.726	0.801	0.502
Perceived Usefulness	(Chen Ying et al., 2015)	4	0.821	0.687-0.764	0.822	0.537
Perceived Enjoyment	(Wojciechowski & Cellary, 2013)	3	0.776	0.676-0.796	0.780	0.543
Attitude	(Chu & Chen, 2016)	3	0.881	0.827-0.866	0.882	0.714
Behavioral Intention	(Chu & Chen, 2016	3	0.877	0.810-0.892	0.897	0.745
Subjective Norm	(Taylor & Todd, 1995b)	4	0.903	0.776-0.890	0.904	0.704
Perceived Behavioral Control	(Taylor & Todd, 1995b)	4	0.873	0.760-0.848	0.875	0.637
Actual System Usage	(Alam et al., 2019)	3	0.901	0.871-0.899	0.915	0.782

Source: Constructed by the author

Table 3: Results of Confirmatory Factor Analysis, Average Variance Extracted (AVE) and Composite Reliability (CR)

	AU	SN	PBC	BI	PE	PU	AT	PEOU
AU	0.884							
SN	0.597	0.839						
PBC	0.300	0.253	0.798					
BI	0.650	0.569	0.356	0.863				
PE	0.510	0.567	0.248	0.583	0.737			
PU	0.453	0.450	0.269	0.457	0.616	0.733		
AT	0.459	0.545	0.224	0.486	0.638	0.464	0.845	
PEOU	0.420	0.519	0.219	0.457	0.662	0.406	0.569	0.709

Source: Constructed by the author

4.3 Structural Equation Model (SEM)

Following the CFA method, the structural equation model (SEM) was implemented to estimate a specific system of linear equations and validate the model's fit. Additionally, SEM determines the causal relationship between each variable in a certain matrix and takes into account estimate inaccuracy or unfaithfulness in the associated coefficient (Jaruwanakul, 2021).

After adjustment by SPSS AMOS 18 software, the fit indices in the SEM validation of this study were acceptable (see Table 4).

Table 4: Goodness of Fit for Structural Equation Model

Index	Acceptable Value	Source	After Modification
TLI	TLI > 0.90	Kline (2015)	0.946
NFI	NFI >0.90	Kline (2015)	0.918
CFI	CFI > 0.90	Hair et al. (2006)	0.953
GFI	GFI ≥ 0.90	Hooper et al. (2008)	0.903
AGFI	AGFI ≥ 0.85	Schermelleh-engel et al. (2003)	0.881
RMSEA	RMSEA < 0.05	Hu and Bentler (1999)	0.049
CMIN/DF	CMIN/DF<3	Hair et al. (2009)	2.207

Source: Constructed by the author

4.4 Hypothesis Testing Result

The significances of every variable in the research model of the study were assessed by its regression weights and R^2 variance. The largest influence on the use of VR technology in learning was behavioral intention, which with the standardized path coefficient (β) resulted in 0.717. The determinants of behavioral intention for the use of VR technology in learning were subjective norm, perceived behavioral control, and attitude. The determinants of attitude for the use of VR technology in learning were perceived ease of use, perceived usefulness, and perceived enjoyment, and perceived ease of use had influenced perceived usefulness with β as 0.685, perceived ease of use had impacted perceived enjoyment with β as 0.527. Therefore, all the hypotheses have been supported with a significance level of the p-value less than 0.05 (see Figure 2).

H1 is the perceived ease of use that is a part of the TAM is assumed to have a positive effect on perceived usefulness. Other studies have found that perceived ease of use has a positive effect on perceived usefulness (Fussell & Truong, 2021; Manis & Danny, 2019; Raja & G, 2022). The normalized path coefficient was 0.685, indicating that the perceived ease of use can be considered to have a large effect on the perceived usefulness (larger than 0.66). Perceived ease of use can be a crucial structure in other models involving the use of VR in education.

H2 has demonstrated that perceived usefulness is an essential component in attitude. This hypothesis is confirmed by a normalized path coefficient of 0.216 and the smallest path coefficient, implying that perceived usefulness has a minor influence on attitude (small as ≤0.33). The discovery that perceived usefulness has a favorable effect on attitude is consistent with previous studies on VR technology (Jimenez et al., 2021; Manis & Danny, 2019; Raja & G, 2022).

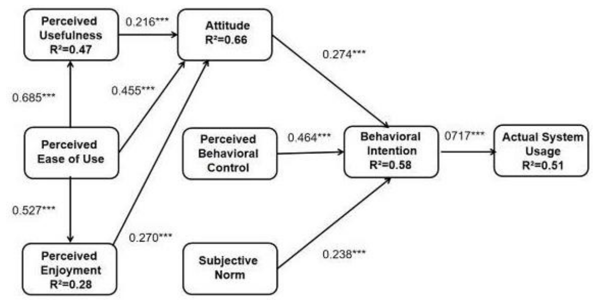

Figure 2: Structural Equation Model (SEM)

For the H3, perceived ease of use is a component of TAM that is anticipated to have a favorable influence on attitude. This hypothesis is validated by a standard coefficient of 0.455, indicating a moderate influence on attitude (moderate about 0.33-0.66). This conclusion is consistent with prior studies and demonstrates that students' views about learning with VR technology are positively influenced by the perceived ease of use of VR devices (Jimenez et al., 2021; Manis & Danny, 2019; Raja & G, 2022). Based on this analysis and consistent with previous research findings, it can be concluded that the perceived ease of use of VR devices may be an important and significant determinant of students' attitudes towards learning with VR technology.

H4 discovered that perceived ease of use impacts perceived enjoyment, yielding a standard coefficient value of 0.527. This conclusion is consistent with the findings of other investigations (Manis & Danny, 2019; Jimenez et al., 2021). The positive relationship between perceived ease of use and perceived enjoyment demonstrates that the ease of use of VR hardware devices improves students' appreciation of the instructional process. Based on this study and prior research findings, it can be stated that students' perceived ease of use of VR hardware may be a significant factor of students' perceived enjoyment of VR technology for learning.

Furthermore, in the condition of H5, the research results supported that perceived enjoyment has significantly affected perceived usefulness with the standard coefficient value at 0.270 which proves that students' perceived enjoyment in the process of learning with VR technology may affect students' attitude toward learning with VR technology. Davis et al. (1992) discover that perceived usefulness and perceived enjoyment influence intention and use behavior indirectly via their effect on attitude. in line with the findings of this investigation. Based on the findings of this study and other research, it is possible to infer that perceived enjoyment of VR devices is an essential and substantial factor in students' attitudes towards learning with VR technology.

In terms of H6, the findings indicate that attitude has a beneficial influence on behavioral intention. The standard coefficient value of 0.274 supports this idea. This finding is identical to the results of other studies (Huang et al., 2010; McDonough et al., 2001; Merchant et al., 2014). The positive effect of attitude on behavioral intention reveals that students' attitudes regarding adopting VR technology in learning have an impact on students' behavioral intention to use VR technology in learning. Based on this study and earlier research findings, it is feasible to conclude that students' attitude towards learning with VR technology may be an essential and significant determinant of students' behavioral intention for learning with VR technology.

H7 has confirmed that perceived behavioral control is one of the essential factors for the behavioral intention, with the standardized path coefficient value at 0.464 in the structural approach. This finding is consistent with other research and suggests that perceived behavioral control has a positive effect on students' intention to adopt VR technology in their learning (Elie-Dit-Cosaque et al., 2011). Therefore, it can be concluded that perceived behavioral control may be a determinant that positively influences students' intention to adopt VR technology in their learning.

For the H8, the correlational statistics consequence supported the hypothesis of the significant impact of subjective norm on behavioral intention which described the standard coefficient value at 0.238. This finding is consistent with other research and suggests that subjective norm has a positive effect on students' behavioral intentions for learning with VR technology (Boateng et al., 2016; Marcinkiewicz & Regstad, 1996; Vidanagama, 2016). The support of important people around them is crucial for students who desire to learn with VR technology. Based on this study and previous data, it is conceivable that subjective norms may be a small but important determinant of students' behavioral intentions to learn with VR technology.

Finally, the correlational statistics consequence supported the hypothesis of the significant impact of behavioral intention on actual system usage which described the standard coefficient value at 0.717. H9 is supported. This is a very large effect size (large ≥ 0.66). This finding is consistent with other studies (Fussell & Truong, 2021; Venkatesh et al., 2008). Additionally, behavioral intention is commonly acknowledged as a prerequisite for actual system usage. The positive effect of behavioral intention on actual system usage reveals that behavioral intention to learn with VR technology is influenced by their learning with VR technology. Based on this analysis and consistent with previous research findings, it can be concluded that behavioral intention using VR technology may be an important and significant determinant of students' adoption of VR technology for learning (see Table 5).

Structural equation modelling allows the direct and indirect effects of each component to be found in terms of the whole research model (Lee, 2006). In terms of the interaction between the variables, there are both direct and indirect influences between the variables. Perceived ease of use has a direct effect on perceived enjoyment, perceived usefulness, and attitude. Perceived enjoyment has a direct effect on attitude. Perceived usefulness had a direct effect on attitude. Attitude, subjective norm, and perceived behavioral control all had a direct effect on behavioral intention had a direct effect on actual system usage and was the highest value.

Perceived ease of use has an indirect effect on attitude, mediated by both perceived usefulness and perceived enjoyment. perceived ease of use has an indirect effect on behavioral intention, mediated by attitude. Perceived ease of use has an indirect effect on actual system usage, mediated through attitude and behavioral intention. Subjective norm has an indirect effect on actual system usage, mediated through attitude and behavioral intention. Perceived enjoyment has an indirect effect on both behavioral intention and actual system usage. Attitude has an indirect effect on actual system usage, mediated through behavioral intention (see Table 6).

Table 5: Goodness of Fit for Structural Equation Model

Hypotheses	Paths	Std.(β)	S.E.	Unstd.	t-value	Accepted / Rejected
H1	PEOU→PU	0.685	0.068	0.689	10.193***	Accepted
H2	PU→AT	0.216	0.068	0.238	3.515***	Accepted
H3	PEOU→AT	0.455	0.082	0.503	6.124***	Accepted
H4	PEOU→PE	0.527	0.062	0.521	8.404***	Accepted
H5	PE→AT	0.270	0.058	0.330	5.671***	Accepted
H6	AT→BI	0.274	0.050	0.262	5.221***	Accepted
H7	PBC→BI	0.464	0.057	0.469	8.195***	Accepted
H8	SN→BI	0.238	0.041	0.229	5.616***	Accepted
H9	BI→AU	0.717	0.059	0.780	13.221***	Accepted

Source: Constructed by the author

Table 6: Standardized Direct Effects (Standardized Indirect Effects) Between Variables

	PBC	SN	PEOU	PE	PU	AT	BI	AU
PE	0.000 (0.000)	0.000 (0.000)	0.527 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
PU	0.000 (0.000)	0.000 (0.000)	0.685 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
AT	0.000 (0.000)	0.000 (0.000)	0.455 (0.304)	0.296 (0.000)	0.216 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
BI	0.464 (0.000)	0.238 (0.000)	0.000 (0.208)	0.000 (0.081)	0.000 (0.059)	0.274 (0.000)	0.000 (0.000)	0.000 (0.000)
AU	0.000 (0.333)	0.000(0.171)	0.000(0.149)	0.000 (0.058)	0.000 (0.043)	0.000 (0.197)	0.717 (0.000)	0.000 (0.000)

Source: Constructed by the author

5. Conclusions and Recommendations

5.1 Conclusions

The study has two research objectives, one is to examine the factors that affect the actual system use of VR technology for learning among undergraduate students at Sichuan Communication University in Chengdu, China. The other was to investigate the relationship between variables that have a significant impact on actual system use of VR technology for learning. Therefore, hypotheses were established as a research model framework to study how perceived ease of use, perceived enjoyment, perceived usefulness, subjective norm, behavioral intention, and perceived behavioral control affect actual system use of VR technology. Questionnaires were issued to all students in the Design College of Sichuan University of Media and Communications who had studied using VR technology. 460 classmates were selected as a research sample by stratified sampling. The study model's validity and reliability were assessed via CFA, and the model was revised based on the results. Applying SEM to investigate the factors influencing college students' utilization of VR technology in their academics. The results of the study are as follows. To begin with, behavioral intentions have the largest influence on college students who use VR technology in their academics. Previous research on e-learning has discovered that behavioral usage intentions have a direct and considerable effect on the actual use of e-learning systems, and this assumption is corroborated in the current study (Abbad et al., 2009; Al-Gahtani, 2016; Mahmodi, 2017). Second, subjective norm, perceived behavioral control, and attitude are the factors that significantly affected behavioral intention, which is consistent with previous research findings (Morris & Dillon, 1997; Rotchanakitumnuai & Speece, 2009). Third, the study discovered a positive correlation between actual system usage of VR technology and perceived enjoyment (Davis & Venkatesh, 2004). Fourth, from the technical dimension, the research verifies the positive influence of perceived ease of use and perceived usefulness on attitude. Numerous studies have validated this section's content source and technology acceptance model (Mathieson, 1991; Taylor & Todd, 1995b). Fifth, the study confirmed the effects between variables, including direct and indirect effects between variables, with particular attention to indirect effects between variables, confirming that perceived ease of use has an indirect effect on attitude through perceived usefulness and perceived enjoyment (Fussell & Truong, 2021). Attitude, perceived behavioral control, and subjective norm have indirect effects on actual system usage through behavioral intention (Fussell & Truong, 2021; Manis & Danny, 2019; Venkatesh & Davis, 2000). In summary, the results of this study, answer the research questions and are consistent with the research objectives.

5.2 Recommendations and Further Research

The results of this study confirm the factors that influence the use of VR technology in learning among college students in Chengdu, China; therefore, the authors recommend that VR hardware and software manufacturers aim to make VR teaching tools beneficial and easy to use. Also, it is recommended that teachers help students and parents understand VR and increase students' behavioral intention to learn using VR technology by expanding training in VR technology.

Future research will extend to different age groups to examine the factors that influence students' behavioral intentions and behaviors when using VR technology while learning at different ages. It should be noted that age may act as a moderator of perceived enjoyment in terms of attitude. Allowing the use of VR technology in teaching and learning at as many different levels as possible will contribute to improving the quality of instruction and the distance learning experience. Second, future research will evaluate the use of VR technology in online teaching environments or in face-to-face teaching environments in offline laboratories. Research in this area could lead to richer scenarios for the use of VR technology in teaching and learning. Finally, the possibility of using VR technology in special education is investigated. Thanks to advances in instructional technology, more people with disabilities will be able to access schools and the future of education will be more equal.

5.3 Limitation

The following are the currently known research restrictions. The findings were confined to college students who participated in 2020 and 2021 as empirical research. The researchers created a virtual reality game for a videography course and evaluated it in a course at Sichuan University's Design College of Media and Communications. Prior to any future applications, appropriate adjustments to the research model should be explored. Depending on their teaching style and topic, teachers frequently modify the assessment rate and manner of virtual reality technology. Simultaneously, varied educational content and progress will result in varying weights for the usage of virtual reality technology. Therefore, the use of virtual reality technology cannot represent the comparable data of different course contents and lecturers. The total number of courses employing virtual reality technology in this study was 8 hours. Differences in the amount of virtual reality courses used may induce alterations in the study's outcomes. Ultimately, virtual reality technology was declared mandatory in the classroom, and students utilized it at the request of their instructors. The survey results may not be generalized to voluntary settings.

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