



# The Impact of Using Virtual Reality on Student Learning Experiences

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## Abstract

## Original Research Article

This study aims to assess students' opinions regarding the use of VR to improve learning experiences by examining factors like ease of use and usability on immersion VR. In the context of higher education, this study evaluates the opinions of students from various diverse backgrounds regarding whether immersive technology can improve their learning experience and their level of engagement. The study applied a causal approach to examine how VR affects students' learning outcome. The questionnaire was completed by 261 respondents in total. Partial least square structural equation modeling (PLS-SEM) was used as an integrating technique to examine the data. The results show that both perceived ease of use and usability of VR play an important role in enhancing students' immersion in the VR environment. This immersion positively influences cognitive benefits, reflective thinking, and perceived learning, supporting the proposed relationships between these variables. The model demonstrated strong predictive accuracy, confirming that VR immersion significantly contributes to improved learning outcomes. This study provides new aspects of the role of VR in education. These findings expand the current understanding of educational technology and propose future research directions and practical applications, emphasizing the need for collaboration among stakeholders to integrate VR effectively into educational systems through changes in policies, environments, and infrastructure.

**Keywords:** virtual reality, education, learning experience, immersive VR, PLS-SEM.

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## 1. Introduction

In the context of digital transformation in education, virtual reality (VR) is becoming an important trend in education in the 4.0 era (Yusof et al., 2019). In 2023, the global market for virtual reality in education was estimated to be worth USD 11.88 billion. The market is anticipated to expand at a compound annual growth rate (CAGR) of 39.1% from USD 16.42 billion in 2024 to USD 61.55 billion by 2028 (The Business Research Company, 2024). VR

creates an interactive and immersive learning environment that provides unique and engaging learning experiences for students (Fitrianto & Saif, 2024). The application of VR in education enhances student interaction and engagement, reduces pressure, creates an enjoyable learning environment, promotes inclusion, and develops soft skills. VR can be developed for use in the classroom in a variety of ways: VR headsets allow for immersive learning in a virtual environment, are affordable, and are easily



accessible. With a headset-free approach, immersive classrooms allow for VR content to be projected onto the classroom (Ibodullayev & Bahromov, 2020). Both approaches are known as experiential learning. Experiential learning emphasizes learning through experience, which is the core element of VR applications (Guerra-Tamez, 2023). By simulating real-life situations, VR allows students to practice skills in a risk-free environment, thereby improving their ability to understand and retain material. This is especially beneficial in areas such as medical training, where students can gain hands-on experience without the risks associated with real-life practice. VR promotes active learning by immersing students in virtual environments where they can interact with content in ways that traditional methods cannot provide.

Current research on virtual reality (VR) in education has always emphasized its potential to enhance student learning, engagement, and educational outcomes. Baxter & Hainey (2019) highlight students' perception of VR as a valuable tool for pedagogy while Wang et al (2023) demonstrates its effectiveness in improving social capacity. Together, these studies highlight the growing role of VR in modern education, particularly in terms of its ability to promote interactive and enriching learning experiences. To enhance these experiences further, VR environments must be designed to be intuitive and engaging. Features like adaptive learning pathways, which allow students to learn at their own pace, and personalized feedback can play a crucial role in keeping learners motivated and focused. By enabling students to adjust their learning approach, VR creates a more inclusive and supportive environment for individual progress.

However, several limitations remain in current research on VR. Notably, variables such as usability and perceived ease of use in VR applications have not been fully explored in many studies. This highlights the need for further investigation to better understand how these factors impact learning outcomes, as they are crucial in determining whether VR can be effectively integrated into various educational settings. Additionally, limitations such as small sample sizes (61 students) (Molina-Carmona et

al., 2018) and demographic imbalances (Thomann et al., 2024) restrict the generalizability of findings, making it challenging to apply the results across diverse student populations. Another limitation is the predominant focus on short-term learning outcomes without examining long-term knowledge retention. Most current studies evaluate VR's immediate effects but do not investigate whether these interventions support students in retaining and applying knowledge over time. This raises questions about the sustainability of VR's impact on education, particularly regarding its ability to foster lasting learning benefits for students.

Existing studies on virtual reality (VR) in education often focus on specific outcomes without evaluating the broader impact on the overall learning experience. For example, Thomann et al (2024) primarily assessed immediate knowledge acquisition but did not examine long-term retention or the practical application of learned skills. This narrow focus highlights a significant gap in understanding the full potential of VR in supporting sustained learning over time. Furthermore, there are noticeable inconsistencies in findings regarding VR's effectiveness. While Molina-Carmona et al (2018) reported significant improvements in spatial abilities through VR, Thomann et al (2024) found no immediate knowledge gains compared to traditional methods. These conflicting results indicate the need for further research into how different elements of VR, such as immersion and interactivity, affect learning outcomes.

In addition to these gaps, many studies do not adequately explore user experience factors, such as perceived ease of use and usability, which are crucial for the successful implementation of VR in educational settings. This oversight can result in the development of VR applications that fail to engage students effectively or optimize the learning experience. Addressing these issues is essential for ensuring that VR tools are both practical and widely adopted by educators and students alike. A further limitation is the generalizability of current research, as many studies rely on small sample sizes or focus on specific educational contexts. As Wang et al (2023) noted, the small number of participants in

these studies restricts the applicability of their findings to broader populations. Research that spans multiple disciplines and includes larger, more diverse participant groups is needed to ensure that results can be generalized across various educational settings.

Another overlooked aspect in the literature is the impact of demographic variables on students' VR learning experiences. Few studies have examined how factors like age, gender, or socioeconomic background affect the effectiveness of VR as an educational tool. Understanding how different groups respond to VR can help inform more inclusive and tailored educational approaches, ultimately enhancing VR's overall efficacy in diverse learning environments.

By addressing these gaps, the current study seeks to contribute to a more nuanced understanding of the role of VR in education. This research aims to ensure that VR applications are aligned with the diverse needs of students and applicable across different learning environments. Additionally, it will help refine the conceptual framework for VR's educational impact and propose strategies for more effective integration of VR into educational practices. To elucidate the problems and help close the aforementioned research gaps, this study addresses the following main objectives: (1) Analyze the impact of perceived ease of use and usability on VR immersion. (2) Clarify the impact of VR usage on students' learning experiences. (3) Determine the impact of VR immersion on students' experiences in the learning environment. The objectives are to explore how usability and perceived ease of use of VR affect students' VR immersion.

## 2. Literature review

### 2.1. Theoretical foundation

Based on psychological theories, the technology acceptance model aims to explain how users are encouraged to accept and use new technology. In the context of applying virtual reality in education, TAM serves as a theoretical foundation for understanding how students perceive and adopt Virtual Reality (VR) technology. TAM is a theoretical extension of

Theory of Reasoned Action (TRA) (Davis, 1989) but narrows the focus to technology use, suggesting that technology-specific beliefs significantly shape users' intentions to use technology (Weerasinghe & Hindagolla, 2017). TAM and its extensions have been utilized for a variety of purposes in a variety of disciplines, contexts, and geographical locations, providing an essential theoretical tool for predicting user behavior (Marikyan & Papagiannidis, 2023). TAM has been used in other disciplines, such as marketing and advertising (Gefen et al., 2003). TAM was utilized to examine how customers evaluate the online shopping tools that support their decision to make a purchase through e-commerce platforms. It was established that TAM constructs, in addition to trust, account for a sizable amount of the variation in attitudes toward IS tools and ensuing customer behavior (Gefen et al., 2003).

TAM proposes two factors as important determinants of user acceptance: perceived usefulness and perceived ease of use (Davis, 1989). The model in this study uses usability instead of perceived usefulness. Because this research is using the model which is a variable of cognitive benefit. Cognitive benefit and perceived usefulness have almost the same meaning as they both refer to the expected benefits of technology in achieving goals. Usability refers to the user interface design and ease of navigation in virtual reality platforms (Huang & Lee, 2019). Meanwhile, perceived ease of use is defined as the extent to which a person believes that using a technology is easy for them (Davis, 1989). The model demonstrates that users perceive the value of VR based on external factors, such as system design features and user training, which influence cognitive responses, which in turn shape attitudes toward using the technology and ultimately influence actual usage behavior (Marikyan & Papagiannidis, 2023).

### 2.2. Hypothesis development

#### 2.2.1. The relationship between Usability and Perceived Ease of Use in Immersive VR

Perceived ease of use (PEU) states that users are more likely to adopt a technology if they find it

easy to use. In an educational setting, this perception can significantly impact students' emotional desire to engage with VR technologies. User-friendly interfaces that prioritize simplicity and intuitiveness can enhance PEU, making it easier for both students and educators to effectively use VR tools (Bačnar et al., 2024). Students who are open to new experiences tend to see VR as a useful and engaging educational tool, which further reinforces the desire to adopt such technologies. Additionally, immersive VR in learning provides an engaging and immersive experience that can keep learners engaged in what they are doing, while VR offers an easy-to-use interface that makes it easy for instructors and students to access tools quickly and easily (de Klerk et al., 2019). Therefore, the hypotheses will be:

Hypothesis 1: Perceived ease of use of virtual reality (VR) technology positively influences the intention to use this technology in education.

The variable "usability" is important in VR development because it helps identify barriers that may hinder user interaction, effective usability tests can reveal issues related to navigation, clarity of interaction, and comfort, allowing developers to fine-tune their applications to better engage users (Fink et al., 2023; Sukirman et al., 2024). The immersive experience allows for better understanding and interaction with the virtual interface, resulting in a more favorable user experience (Guerra-Tamez, 2023).

Having conducted a survey to evaluate the usability of a VR application for training students in practical skills, the authors validated the effectiveness of the VR application using the System Usability Scale (SUS) and analyzed the collected data on participants' perceptions. VR in education yielded positive results, with participants finding the learning experience enjoyable, VR increased user engagement, which correlated with higher perceptions of usability. More engaged users generally found the technology easier to use, while users reported feeling more comfortable and confident using immersive VR, which further enhanced their perceptions of usability (AlGerafi et al., 2023). Therefore, the hypotheses will be:

Hypothesis 2: Usability in virtual reality environments has a positive influence on student VR immersion.

### 2.2.2. Immersion VR in Cognitive Benefit, Reflective Thinking, Perceived Learning

Cognitive benefits of VR input are multifaceted, working with engagement, learning effectiveness, empathy, and cognitive processing. As VR technology continues to develop, its applications in education and health contexts are likely to expand, further demonstrating the potential for immersive experiences to enhance user outcomes in a variety of fields/different fields.

The main benefits of VR input are increased engagement and motivation, Immersion in VR allows users to feel physically present in the virtual environment, which can bridge the psychological gap, and the Experience should be more direct and personal. This increased engagement results in increased energetic connection and a deeper connection to the material presented (Christopoulos et al., 2024; Liao, 2024). Research shows a strong correlation between user enjoyment and perceived learning effectiveness in VR settings. When users find VR experiences enjoyable, they are more likely to consider them effective for learning (Christopoulos et al., 2024; Guerra-Tamez, 2023). So, the hypothesis is:

Hypothesis 3. Cognitive benefits are positively impacted by immersive VR.

Integrating immersive Virtual Reality into educational activities significantly enhances critical thinking skills in learners. By providing a safe, interactive environment for experimentation, promoting engagement through visualization, and facilitating collaborative learning experiences, VR serves as a transformational tool for students. Prepare to solve complex real-world problems. As educational technologies continue to advance, VR's role in enhancing critical thinking is likely to expand further, providing new opportunities for effective learning experiences.

The immersive nature of VR allows learners to conduct experiments without the risks associated with real-world experiments. This safety

encourages students to take intellectual risks, make mistakes, and learn from them—important elements for developing reflective thinking skills. By simulating real-world situations, VR allows learners to practice problem solving in a controlled environment. This enhanced engagement leads to increased motivation to explore and understand topics complex topics, fostering an environment where critical thinking can thrive. When students are motivated and interested, they are more likely to engage in critical thinking and analysis (Guerra-Tamez, 2023; Liao, 2024). So, the hypothesis would be:

Hypothesis 4. Reflective thinking is positively impacted by immersive VR.

The perceived learning of immersive VR is positively impacted by realism, user engagement, emotional connection, effective learning, contextual relevance, and visual effectiveness. As VR technology continues to develop and integrate into a variety of sectors, its

ability to create meaningful and impactful experiences will likely enhance its perceived value even further among consumers.

The degree to which VR environments simulate real-world situations plays an important role in shaping perceived value. Higher levels of authenticity lead to higher user satisfaction and engagement, as users feel more engaged with the experience. Authenticity in VR experiences promotes trust and credibility, enhancing the overall perceived quality of interactions (Christopoulos et al., 2024; Hameed & Perkis, 2024). Studies have shown that experiential learning through VR leads to better knowledge retention than traditional methods. This effectiveness contributes to the perceived usefulness and value of VR as an educational tool (Christopoulos et al., 2024). So, the hypothesis would be:

Hypothesis 5. Perceived learning is positively impacted by immersive VR.

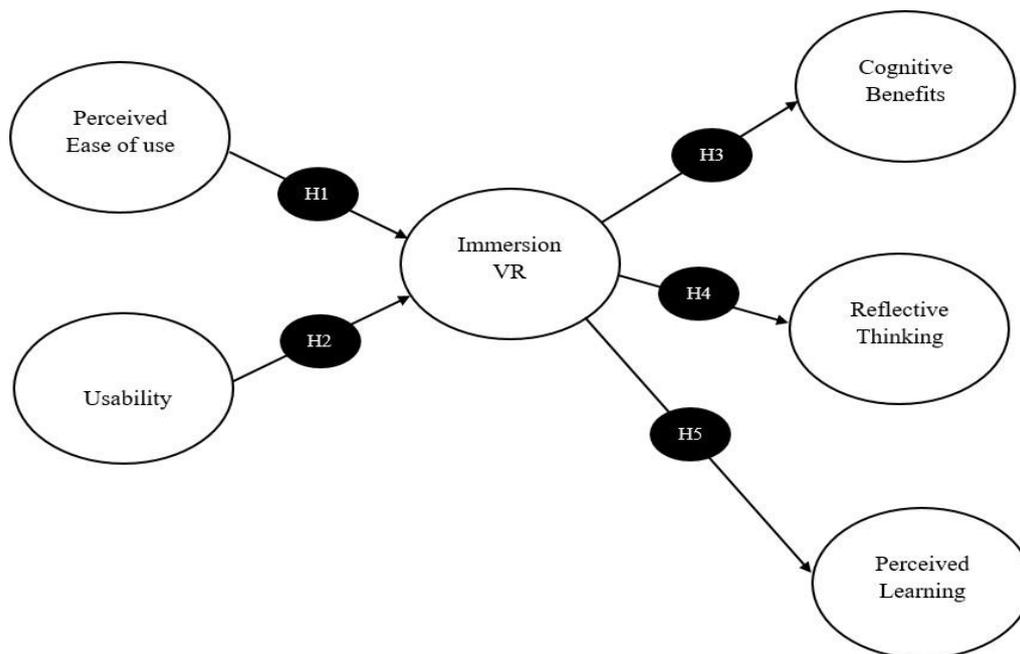


Figure 2.1. Research model  
Soucre: created by author

### 3. Methodology

#### 3.1 Sampling method

The current study used a conditional non-probability sampling method to recruit

respondents suitable for the study's purpose. Two criteria were applied to achieve this purpose: (1) respondents had to have used virtual reality immersion and (2) had a high frequency of use. The sampling technique was considered

appropriate when only a certain number of respondents possessed the necessary information.

One study showed that using VR tools to teach three-dimensional vectors resulted in better student performance than traditional methods, especially in visualization tasks (Campos et al., 2022; Lin et al., 2024). Research has shown that virtual reality (VR) technology is a powerful tool for enhancing student engagement. By creating immersive and realistic learning experiences, VR not only captures students' attention but also helps them understand and retain knowledge longer. Other research suggests that VR can effectively support the development of practical skills. The required sample size for this study was 150. After eliminating ineligible responses, we obtained a total sample size of 261, which exceeded the minimum sample size.

### 3.2 Sample size

In addition, through the calculator by (Soper, 2024), which is suggested by (Westland, 2010) the recommended minimum sample size is 161. The following settings were made in the calculator.

- Anticipated effect size: 0.3
- Desired statistical power level: 0.8 (Cohen, 1988)
- Probability level: 0.05
- Number of latent variables: 6
- Number of observed variables: 23

Therefore, from the justification above, the minimum sample size usable for data analysis comprised at least 161 responses to be able to meet the analysis in the next sections. This study has 261 samples that are eligible for additional analysis after surveying and removing unqualified samples; this number surpasses the necessary number of sample sizes.

### 3.3 Questionnaire design

To collect data, we deployed an electronic questionnaire through Google Forms. This platform helped us reach a large number of

participants such as students and collect data quickly and conveniently. A 7-point Likert scale was used to measure the participants' views, and the questionnaire used a 7-point Likert scale, allowing respondents to express their level of agreement or disagreement in detail. In the questionnaire, VR immersion (IM), cognitive benefits (CB) from (Guerra-Tamez, 2023) reflective thinking (RT), and perceived learning (PL), and Usability (US) from (Serna-Mendiburu & Guerra-Tamez, 2024). Perceived ease of use (PEU) accepted by (Davis, 1989). This questionnaire aims to survey more accurate opinions, providing more emotions and feelings as well as students' own experiences when using VR technology.

The main variable used to evaluate the survey is Immersion VR (IM), which is used to evaluate the experience and feelings of the survey respondents when using. Cognitive benefits (CB) are used to evaluate the perceived benefits that VR brings to learning. Besides, the equally important variable is Perceived ease of use (PEU). This variable evaluates the level of ease that users feel when using VR, directly affecting their motivation to use VR in learning. The purpose of this questionnaire is to survey and collect many different opinions, then based on that data, analyze the influence.

## 4. Result

### 4.1. Demographics

According to Table 4.1, the survey data shows that demographic profile of 261 respondents. In which there are 173 female students (66.28%) and 88 male students (33.72%). This ratio is relatively differentiated and makes the model more reliable. Accordingly, the number of students in the academic years includes 12 first-year students (4.60%), 27 second-year students (10.34%), 54 third-year students (20.69%) and 168 fourth-year students (64.37%). Specifically, there are 150 students (57.47%) from the Faculty of Business Administration, 28 students (10.73%) from the Faculty of International Relations, 25 students (9.58%) from Economics - Finance, 19 students (7.28%) from the Faculty of Foreign Languages, 13 students (4.98%) from the Faculty of Law, 10 students (3.83%) from the

Faculty of Tourism and Hospitality and Information Technology, and 6 students (2.30%) from the Faculty of Oriental Languages and Cultures. Regarding the use of virtual reality

technology, there are 131 students (50.19%) who use it sometimes, while 130 students (49.81%) use this technology usually during the learning process.

Table 4.1. Demographic profile (N=261)

Demographic characteristic		Frequency	Percentage
<b>Gender</b>	Female	173	66.28%
	Male	88	33.72%
<b>Year</b>	1	12	4.60%
	2	27	10.34%
	3	54	20.69%
	4	168	64.37%
<b>Faculty</b>	Business Administration	150	57.47%
	International Relations	28	10.73%
	Economics - Finance	25	9.58%
	Foreign Language	19	7.28%
	Law	13	4.98%
	Tourism – Hospitality	10	3.83%
	Information Technology	10	3.83%
	Oriental Languages and Cultures	6	2.30%
<b>Frequency</b>	Sometimes	131	49.81%

	Usually	130	50.19%
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#### 4.2. Descriptive statistics

Based on the descriptive statistics from Table 4.2, provides insights into the impact of Virtual Reality (VR) on students' learning experiences, showing positive perceptions across several key aspects. Immersion VR (IM) with a mean score of 5.46 suggests that students feel strongly engaged while using VR, pointing to VR's ability to capture attention and pull students into the learning experience. The standard deviation of 0.99 shows some variation in how students respond, which could be due to personal differences in how deeply they connect with VR content. Next, Usability (US), with an average score of 5.44, shows that students find VR platforms well-structured and easy to navigate. This usability factor is important in an educational setting, as it enables students to interact with VR smoothly and without unnecessary challenges. The standard deviation of 0.85 reflects consistency in students' views, underscoring a shared experience of VR's accessible design. Perceived Ease of Use (PEU), with a mean score of 5.42, also reflects that students find VR straightforward to use, which can reduce barriers to adopting this technology in a learning environment. A standard deviation of 0.84 indicates high agreement, suggesting that most students find VR interfaces intuitive and in line with their expectations. Cognitive Benefit

(CB) holds a mean of 5.51, suggesting that students perceive VR as supportive of cognitive skills like critical thinking and problem-solving. The standard deviation of 0.96 shows slight variability, which might reflect different levels of cognitive engagement depending on individual preferences or familiarity with VR. Reflective Thinking (RT) scores an average of 5.43, indicating that VR encourages deeper reflection among students. The immersive nature of VR may allow students to analyze and critically assess their learning more thoroughly. However, the standard deviation of 0.94 suggests some diversity in experiences, likely due to differences in how students engage with VR content. Finally, Perceived Learning (PL) has the highest score at 5.57, showing that students see VR as a valuable addition to their education. This strong perception may reflect VR's interactive and immersive qualities that make learning more impactful. The standard deviation of 0.87 further supports the consistency of this positive view.

In summary, the similarity in mean scores and low standard deviations across these constructs reflect a generally uniform perception of VR's positive role in learning. VR is seen as enhancing various aspects of the educational experience, from usability and cognitive benefits to ease of use and reflective thinking, making it a promising educational tool.

Table 4.2. Mean and Std. deviation of construct

Construct		Mean	Std. Deviation
Immersion VR	IM	5.46	0.99
Usability	US	5.44	0.85

Perceived Ease of Use	PEU	5.42	0.84
Cognitive Benefit	CB	5.51	0.96
Reflective Thinking	RT	5.43	0.94
Perceived Learning	PL	5.57	0.87

### 4.3. Common method bias (CMB)

VIF greater than 3.3 is recommended as an indicator of pathological collinearity, as well as the possibility that a model is tainted by common method bias. As a result, if all VIFs in the outer model obtained by a comprehensive collinearity test are equal to or less than 3.3, the model can be regarded free of common method bias (Kock, 2015). As shown in Table 4.3, we performed the full collinearity test using a random dependent variable and discovered that the maximum variance inflation factor (VIF) value was 1.877, which was considerably below the 3.3 criterion (Le et al., 2025; Nguyen et al., 2025). Based on the findings, it may be assumed that there was no significant common method bias contamination in the data.

### 4.4. Assessment outer model

Before testing the hypotheses in the inner model, the measurement outer model must be examined and validated. To evaluate the measuring model, the study must assess its reliability and validity. To begin, the study assessed convergent validity using the average variance extracted (AVE) and factor loadings (FL). The basic rule of thumb is

that external loading must be at least 0.7 and AVE must be better than 0.5 to be deemed good (Binh et al., 2024; Dang et al., 2026). Table 4.3 shows that all AVE values were higher than 0.5 which the lowest AVE value of 0.535, while all factor loadings values ranging from 0.701 to 0.846 exceed the value of 0.7, meeting the requirements (J. Hair et al., 2017; J. F. Hair et al., 2021). As a result, the convergent validity of this study has been verified. Next, Cronbach's Alpha (CA), composite reliability (CR) include rho\_a and rho\_c may be used to examine the validity (J. F. Hair et al., 2021). As indicated in Table 4.3, CA, rho\_a, and rho\_c have minimum values of 0.711, 0.717, and 0.821, respectively. This result indicates that CA, rho\_a, and rho\_c are confirmed, and that all constructions have consistency dependability, more significant than the required 0.7 (Foo et al., 2018; Tan & Ooi, 2018). Finally, discriminant validity in this study was assessed using two criteria: Fornell-Larcker's criterion (Fornell & Larcker, 1981) and cross-loadings (Henseler et al., 2015). The indicators are loaded highly on their respective constructs, according to the results of the cross-loadings from Table 4.5. Consequently, this study's discriminant validity has been confirmed.

Table 4.3. Measurement model results

	Factor Loadings (FL)	Cronbach's alpha (CA)	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)	VIF	
<b>CB</b>	<b>CB1</b>	0.750	<b>0.778</b>	<b>0.789</b>	<b>0.858</b>	<b>0.601</b>	1.415
	<b>CB2</b>	0.742					1.470
	<b>CB3</b>	0.846					1.822
	<b>CB4</b>	0.759					1.557
<b>IM</b>	<b>IM1</b>	0.728	<b>0.752</b>	<b>0.754</b>	<b>0.843</b>	<b>0.574</b>	1.468
	<b>IM2</b>	0.808					1.709
	<b>IM3</b>	0.780					1.541
	<b>IM4</b>	0.712					1.350
<b>PEU</b>	<b>PEU1</b>	0.804	<b>0.798</b>	<b>0.804</b>	<b>0.869</b>	<b>0.625</b>	1.626
	<b>PEU2</b>	0.820					1.827
	<b>PEU3</b>	0.829					1.877
	<b>PEU4</b>	0.701					1.369
<b>PL</b>	<b>PL1</b>	0.780	<b>0.782</b>	<b>0.790</b>	<b>0.860</b>	<b>0.606</b>	1.561
	<b>PL2</b>	0.765					1.579
	<b>PL3</b>	0.842					1.795
	<b>PL4</b>	0.722					1.425
<b>RT</b>	<b>RT1</b>	0.781	<b>0.726</b>	<b>0.730</b>	<b>0.845</b>	<b>0.645</b>	1.373
	<b>RT2</b>	0.804					1.495
	<b>RT3</b>	0.825					1.437
<b>US</b>	<b>US1</b>	0.707	<b>0.711</b>	<b>0.717</b>	<b>0.821</b>	<b>0.535</b>	1.331
	<b>US2</b>	0.783					1.420
	<b>US3</b>	0.717					1.331
	<b>US4</b>	0.717					1.266

Note(s): a. PEU = Perceived Ease of Use; US = Usability; IM = Immersion VR; CB = Cognitive Benefit; RT = Reflective Thinking; PL = Perceived Learning.

Source: by the authors

Table 4.4. Fornell-lacker criterion

	<b>CB</b>	<b>IM</b>	<b>PEU</b>	<b>PL</b>	<b>RT</b>	<b>US</b>
<b>CB</b>	<b>0.776</b>					
<b>IM</b>	0.701	<b>0.758</b>				
<b>PEU</b>	0.480	0.531	<b>0.790</b>			
<b>PL</b>	0.623	0.649	0.591	<b>0.778</b>		
<b>RT</b>	0.642	0.561	0.486	0.630	<b>0.803</b>	

US	0.553	0.586	0.697	0.606	0.533	<b>0.731</b>
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Note(s): a. PEU = Perceived Ease of Use; US = Usability; IM = Immersion VR; CB = Cognitive Benefit; RT = Reflective Thinking; PL = Perceived Learning.

Source: by the authors

Table 4.5. Cross-loadings

	CB	IM	PEU	PL	RT	US
<b>CB1</b>	<b>0.750</b>	0.545	0.440	0.520	0.429	0.370
<b>CB2</b>	<b>0.742</b>	0.494	0.336	0.433	0.478	0.393
<b>CB3</b>	<b>0.846</b>	0.629	0.402	0.511	0.583	0.499
<b>CB4</b>	<b>0.759</b>	0.490	0.302	0.465	0.495	0.448
<b>IM1</b>	0.574	<b>0.728</b>	0.396	0.444	0.407	0.339
<b>IM2</b>	0.542	<b>0.808</b>	0.447	0.514	0.439	0.457
<b>IM3</b>	0.540	<b>0.780</b>	0.363	0.515	0.420	0.507
<b>IM4</b>	0.470	<b>0.712</b>	0.402	0.493	0.435	0.467
<b>PEU1</b>	0.472	0.403	<b>0.804</b>	0.397	0.407	0.572
<b>PEU2</b>	0.407	0.374	<b>0.820</b>	0.480	0.393	0.530
<b>PEU3</b>	0.408	0.395	<b>0.829</b>	0.476	0.342	0.533
<b>PEU4</b>	0.380	0.340	<b>0.701</b>	0.532	0.392	0.566
<b>PL1</b>	0.500	0.461	0.431	<b>0.780</b>	0.473	0.406
<b>PL2</b>	0.474	0.456	0.505	<b>0.765</b>	0.511	0.462
<b>PL3</b>	0.574	0.547	0.514	<b>0.842</b>	0.528	0.515
<b>PL4</b>	0.465	0.468	0.384	<b>0.722</b>	0.448	0.506
<b>RT1</b>	0.436	0.592	0.417	0.504	<b>0.781</b>	0.447
<b>RT2</b>	0.417	0.483	0.356	0.499	<b>0.804</b>	0.390
<b>RT3</b>	0.493	0.477	0.398	0.516	<b>0.825</b>	0.444
<b>US1</b>	0.377	0.431	0.379	0.435	0.415	<b>0.707</b>
<b>US2</b>	0.482	0.445	0.567	0.405	0.393	<b>0.783</b>
<b>US3</b>	0.397	0.385	0.509	0.455	0.396	<b>0.717</b>
<b>US4</b>	0.447	0.359	0.563	0.486	0.364	<b>0.717</b>

Note(s): a. PEU = Perceived Ease of Use; US = Usability; IM = Immersion VR; CB = Cognitive Benefit; RT = Reflective Thinking; PL = Perceived Learning.

Source: by the authors

#### 4.5. Assessment inner model

Before testing the publication hypotheses, the authors eliminated the possibility of multicollinearity by performing the collinearity test (J. F. Hair et al., 2019). The results from

Table 2 show that the values of the variance inflation factor (VIF) from 1.266 to 1.877, all lower than the threshold of 5.0 (Chin, 2010). Therefore, the possibility of multicollinearity in this study can be ruled out.

Second, with 5,000 subsamples, no sign change, and a 99 percent confidence interval corrected for bias, the bootstrapping procedure was used in this study to collect inferential statistics. According to the hypothesis testing results shown in Table 4.5, PEU and US have significant impacts on IM with p-value < 0.05, therefore, the relationship of each hypothesis H1, H2 is supported. In addition, the results also show that IM significantly affects CB, PL, and RT as all of them have p-values < 0.001. As a result, the relationship of each hypothesis H3, H4, and H5 is supported. Therefore, based on the results of

the Table, the variables are significantly correlated with each other.

The results of hypothesis testing are shown in Table 4.6. PEU and US have significant effects on IM with p value < 0.05, so the relationship of each hypothesis H1, H2 is supported. In addition, the results also show that IM has significant effects on CB, RT, PL with p value < 0.001. As a result, the relationship of each hypothesis H3, H4, H5 is supported. Therefore, based on the results of Table 4.6, the author concludes that the remaining variables are significantly correlated with each other.

Table 4.6. Hypothesis testing

Hypothesis	PLS Path	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics ( O/STDEV )	P values	Remark
H1	PEU → IM	0.238	0.237	0.072	3.288	0.001	Supported
H2	US → IM	0.42	0.417	0.078	5.383	0.000	Supported
H3	IM → CB	0.701	0.700	0.043	16.376	0.000	Supported
H4	IM → RT	0.561	0.559	0.066	8.501	0.000	Supported
H5	IM → PL	0.649	0.647	0.058	11.159	0.000	Supported

Note(s): a. PEU = Perceived Ease of Use; US = Usability; IM = Immersion VR; CB = Cognitive Benefit; RT = Reflective Thinking; PL = Perceived Learning.

Source: by the authors

This study evaluates the predictive accuracy of the structural model using the blinding method to determine the Q<sup>2</sup> value. The study found that the Q<sup>2</sup> value was greater than 0, confirming the predictive relevance of the model (J. Hair et al., 2017). Based on the results in the Q<sup>2</sup> column (=1-SSE/SSO) of Table 4.7, the predictive relevance of the model in this study was confirmed.

Furthermore, to achieve the minimum explanatory power, the R<sup>2</sup> value should be greater than 0.1 (Loh et al., 2021). In this study, the lowest value of R<sup>2</sup> was 0.373, exceeding the threshold of 0.1, indicating that it could explain significant variation in the endogenous target structure (Loh et al., 2021).

Table 4.7. Predictive Relevance (Q<sup>2</sup>) and R<sup>2</sup>

Endogenous variable	Q <sup>2</sup> (=1-SSE/SSO)	Predictive Relevant	R <sup>2</sup>
IM	0.365	Q <sup>2</sup> >0	0.373
CB	0.296	Q <sup>2</sup> >0	0.491
PL	0.346	Q <sup>2</sup> >0	0.422

RT	0.255	$Q^2 > 0$	0.315
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Note(s): IM = Immersion VR; CB = Cognitive Benefit; RT = Reflective Thinking; PL = Perceived Learning.

Source: by the authors

## 5. Discussion

The study contains five hypotheses, each of which is supported by the data. These hypotheses aim to evaluate the effects of Virtual Reality (VR) on student learning by examining factors such as usability, perceived ease of use, and immersion, aligning them with the study's objectives.

The hypotheses support the three main objectives of the study. First, the results confirm that usability and perceived ease of use significantly impact students' VR immersion. This directly aligns with the study's objective of exploring how these factors influence immersion. Secondly, the positive impact of VR immersion on students' cognitive benefits, reflective thinking, and perceived learning demonstrates how VR usage affects essential learning outcomes, fulfilling the objective to assess the effects of VR on learning experiences. Lastly, students respond enthusiastically to VR in learning environments because it enhances engagement, motivation, and a sense of immersion. This experience allows them to connect deeply with the content, supporting cognitive benefits such as critical thinking and problem solving. Additionally, VR encourages reflective thinking, motivates students to analyze their learning process, and increases their confidence in understanding complex material. Overall, VR not only makes learning more fun, but also increases student mastery and satisfaction, creating supportive and impactful educational experiences.

In brief, the hypotheses support the study's goals, showing how VR's usability, ease of use, and immersive aspects contribute to a deeper understanding of its educational benefits.

This study examined and validated how immersion VR affected students' perceptions of learning as mediated by perceived ease of use and usefulness. To examine the various

connections among the variables, a bootstrapping analysis was used. Firstly, we discovered that students' perceptions of usability and convenience of use have an impact on their immersion VR experience. First, the study's findings on perceived ease of use reinforce the criticality of this dimension in education, where understanding are fundamental skills. The significant impact of perceived ease of use on immersion VR (H1) and subsequent educational outcomes echoes the work of Makransky & Lilleholt (2018), Shin (2019) and Pellas et al (2020) who found similar enhancements in perceived ease of use reasoning and immersive among students engaged with VR. This demonstrates how VR may be a powerful tool for skill development, providing immersive experiences that may not be entirely available through traditional educational methodologies.

Secondly, the study's empirical results demonstrate the critical role that virtual reality (VR) plays in improving educational learning outcomes, emphasizing the complex relationship between immersion VR and usability (H2). Notably, our research supports the idea that usability in virtual reality settings greatly enhances learning satisfaction, which is consistent with earlier studies that highlight the value of clear and easy-to-use interfaces in educational technologies. (Violante and Vezzetti, 2015; AlGerafi et al., 2023). In addition, studies by Cooper et al (2018); de Klerk et al (2019) has demonstrated the impact of usability on immersion VR. This association suggests a possible change in the way instructional content is presented and experienced, underscoring the necessity for carefully crafted VR platforms that meet the particular needs of teaching.

Following an explanation of the immersion VR independent variable, the positive correlation between the measure's cognitive benefits, reflective thinking, and perceived learning (Serna-Mendiburu & Guerra-Tamez, 2024;

Guerra-Tamez, 2023) that supposed student's perception of learning was confirmed. Thirdly, the direct correlation observed for incorporating VR into educational curricula is made by the clear link found between student immersion in VR environments and enhanced cognitive benefits (H3). These results support those of Jensen & Konradsen (2018), Makransky et al. (2019), and Chen (2016), who have shown how immersive learning environments can increase cognitive benefits by encouraging a deeper engagement with the material. This highlights the wider educational potential of VR beyond just technological novelty and implies that immersion with VR learning experiences might spark a positive loop of engagement and achievement. (Xu et al., 2022).

Next, the connection between immersion VR and reflective thinking (H4) has the potential to positively affect reflective thinking by providing a realistic, immersive environment that allows users to explore their thoughts and feelings in a non-judgmental, safe manner (Ye et al., 2022). Previous studies by Ye et al (2022), Zhang et al (2017) has demonstrated immersion VR can help to promote understanding, because people can more meaningfully examine their feelings and thoughts. Furthermore, virtual reality (VR) can give users a sense of presence, making them feel as though they are in the virtual world and fostering more reflective thinking (Lackey et al., 2016).

Finally, immersion VR experiences have a positive correlation with perceived learning (H5), which emphasizes how VR can change how students view their academic path. This aligns with the findings of Makransky & Lilleholt (2018), Lee et al (2020), Hewei (2022) and Vishwakarma et al (2020) who observed that after VR interventions, pupils' confidence in their capacity to learn improved. This has significant implications, indicating that virtual reality (VR) not only supports the actual acquisition of knowledge and skills but also raises students' self-efficacy and confidence in their capacity to learn (Shin & Biocca, 2018).

In conclusion, it highlights the prominent of integrating VR technology into educational frameworks by highlighting the critical roles that perceived ease of use and immersion VR play, as

well as the cognitive advantages, reflective thinking, and perceived learning that follow. These results signal a new era of immersive and interactive learning that has the potential to significantly improve the educational landscape and encourage educational stakeholders to adopt VR as a crucial part of modern pedagogical tactics.

## 6. Implication

### 6.1. Theoretical implication

According to the TAM hypothesis, if users find a technology easy to use, they are more likely to consider the technology useful and intend to use it. The effect of perceived ease of use on intention may be mediated by perceived usefulness. If users find VR easy to operate, they are more likely to experience the benefits of the technology more fully, thereby increasing their perceptions of the technology's usefulness in achieving educational goals (Antón-Sancho et al., 2024). Empirical research has shown that integrating VR into educational contexts improves student engagement and learning outcomes. For example, studies have shown that students participating in VR report higher levels of motivation and better understanding of complex subjects due to the immersive nature of the technology. Furthermore, when educators are properly trained in how to effectively use VR tools, their confidence in using these technologies increases, leading to better learning outcomes for students (AlAli & Li, 2024).

Research on the theoretical implications of Virtual Reality (VR) in education highlights its transformative potential in enhancing learning experiences. Constructivist understandings of learning such as VR align with constructivist principles by allowing students to actively engage with content, facilitating deeper understanding through immersive experiences. Research shows that VR significantly increases student engagement and motivation, improving learning outcomes. Students often report that they are more interested in subjects taught through VR. Personalized learning using VR can accommodate individual learning styles and pace, making it a valuable tool for diverse classrooms. This adaptability supports

differentiated instruction. Additionally, VR promotes the development of essential skills such as critical thinking, problem-solving, and collaboration by simulating real-world situations in a safe environment (AlAli & Li, 2024).

The PEU variable has a strong impact on VR adoption. Studies have shown that a significant proportion of users find VR easy to learn and operate, which positively influences their intention to use VR in educational contexts. For example, a survey found that 57% of physical therapists felt that learning to operate VR would be easy, suggesting that ease of use can facilitate faster adoption and integration into educational activities (Vasanthi et al., 2023). Regarding the US variable in VR in education, it can lead to a better user experience, reduce frustration, and increase engagement. The clarity and responsiveness of VR interfaces play a key role in helping educators and students focus on learning rather than struggling with the technology (Sagnier et al., 2020; Wong et al., 2023). VR immersion studies show that users who engage in VR often report improved cognitive processing abilities, such as better spatial awareness and critical thinking skills. The interactive nature of VR encourages active learning, which is known to facilitate deeper cognitive engagement than traditional learning methods (Hernández-Rodríguez, 2023).

## 6.2. Managerial implication

The findings of this study provide valuable insights for administrators and policymakers in the education sector. Policymakers in developing countries are increasingly interested in developing and promoting thinking in young people to meet practical requirements. Especially in Vietnam, in the context of globalization and the strong development of science and technology, the Party has set a goal of "By 2030, Vietnam will be a developing country with modern industry and high average income" (Tran, 2024). To achieve the goal, human resource development is a decisive factor. The findings of this study provide useful information to consider the possibility of applying VR to education in order to help students learn more effectively to enhance their creativity, innovation

and initiative. Based on the survey results of the study, students believe that the use of VR can enhance their learning experience. Administrators and policy makers may consider integrating traditional teaching methods and virtual reality into future learning. A detailed plan and timeline are needed for VR to gradually penetrate the educational environment. In addition, it is necessary to identify VR platforms that are suitable for teaching objectives and a team is needed to ensure technical support to solve arising problems (Goertz et al., 2021).

When introducing VR technology into the curriculum, it is necessary to strongly promote the educational ecosystem. To date, the application of VR technology in foreign curricula has brought great success. The purpose of this paper is to propose a plan for the application of virtual reality (VR) technology in education in Vietnam to modernize the education system and improve the quality of education for students and educators. When implementing, it is necessary to provide training on how to use VR equipment effectively. Familiarity and ease of use with technology can significantly enhance the learning experience (Ding & Li, 2022; Hussein & Nätterdal, 2015). Schools should ensure adequate physical space for VR activities, while also considering the safety and comfort of students as they navigate the immersive environment (Cook & Lischer-Katz, 2020). Integrating Virtual Reality into higher education offers exciting opportunities to enhance the learning experience. By taking structured steps – from assessing learning objectives to assessing effectiveness – educators can successfully incorporate this innovative technology into their teaching methods, ultimately enriching student engagement and understanding. This study also has important implications for the allocation of resources and the creation of educational policies.

In order to examine the long-term effects of virtual reality applications in education on populations that promote learning, the integration of virtual reality (VR) into education. It is important to examine how virtual reality (VR) is incorporated into the classroom. The long-term effects of Extended Reality (XR) applications in education on populations that

promote learning have been the subject of numerous studies. FAMILONI & ONYEBUCHI (2024) provides a thorough examination of the ways in which virtual reality technology can benefit health learners by increasing motivation, promoting engagement, improving cognitive abilities, and improving the overall educational process. Their research provides a thorough examination of the ways in which virtual reality tools can help health learners by boosting motivation, promoting engagement, identifying cognitive development, and improving the overall learning process. They highlight the need for collaborative efforts among all stakeholders to address the formulation and exploit the potential of these technologies. Integrating VR into education requires not only appropriate economic application but also changes in educational settings, policies, and infrastructure. As VR technology continues to evolve, its effective deployment in the educational context will depend on the joint efforts of educators, administrators, and policymakers to create an environment conducive to creative and inclusive learning that can meet the requirements of industrialization and modernization of the country in the future.

#### 5.4. Conclusion and further research

This study aims to explore the role and impact of virtual reality (VR) on students' learning experiences, with a particular focus on three key aspects: ease of use, utility, and the level of immersion that VR can bring to an educational setting. The research seeks to determine whether VR can actively motivate and enhance students' engagement, foster critical thinking skills, and improve cognitive processing within a learning environment. By delving into how an immersive VR experience influences students' ability to comprehend and retain complex knowledge, the study addresses VR's potential to revolutionize traditional teaching methods.

The findings reveal that VR offers substantial and multidimensional benefits in the learning process. The participants reported that VR technology not only boosted their motivation to learn but also allowed them to engage deeply with the course material. The immersive,

interactive environment created by VR provided an experience that transcended conventional teaching approaches, facilitating a sense of presence and engagement that encouraged active learning. Students found that VR enabled them to grasp and retain complex topics more effectively, thanks to the multidimensional visualizations and simulations that traditional educational methods often lack. Moreover, the study highlights that VR not only aids in understanding new concepts but also actively supports the development of critical thinking skills. By presenting realistic, simulated scenarios, VR enables students to connect new knowledge with their prior experiences, fostering a deeper and more analytical approach to learning. This reflective process enhances students' ability to engage in complex reasoning and logical thinking, further enriching their learning journey. Overall, the study demonstrates VR's potential as a transformative tool in education, with the capacity to enhance not only knowledge retention and comprehension but also critical skills that are essential for academic success. These findings underscore the potential of VR to be a core component in educational innovation, helping to equip students with the tools they need for a more engaging, insightful, and effective learning experience.

Although this study shows that VR can significantly improve the learning experience, more research is needed to better understand its long-term effects, especially on knowledge retention. Currently, most research focuses on technical engineering industries, where VR makes good use of interactivity and simulation. However, for VR to better support other fields such as arts and humanities, its adaptability to each field needs to be further evaluated. Furthermore, the scope of this study is quite limited because it only surveyed students. For a more comprehensive view, future studies should expand the scope of the study to include other target groups, such as teachers, administrators, and industry professionals, to assess the evaluations and acceptability of VR in education in general.

## REFERENCES

- AlAli, R., & Li, Y. W. (2024). The Role of Virtual Reality (VR) as a Learning Tool in the Classroom. *International Journal of Religion*, 5(10), 2138–2151. <https://doi.org/10.61707/e2xc5452>
- AlGerafi, M. A. M., Zhou, Y., Oubibi, M., & Wijaya, T. T. (2023). Unlocking the Potential: A Comprehensive Evaluation of Augmented Reality and Virtual Reality in Education. In *Electronics (Switzerland)* (Vol. 12, Issue 18). Multidisciplinary Digital Publishing Institute (MDPI). <https://doi.org/10.3390/electronics12183953>
- Antón-Sancho, A., Vergara, D., & Fernández-Arias, P. (2024). Quantitative analysis of the use of virtual reality environments among higher education professors. In *Smart Learning Environments* (pp. 11–13). <https://doi.org/10.1186/s40561-024-00299-5>
- Bačnar, D., Barić, D., & Ogrizović, D. (2024). Exploring the Perceived Ease of Use of an Immersive VR Engine Room Simulator among Maritime Students: A Segmentation Approach. *Applied Sciences*, 14(18), 8208. <https://doi.org/10.3390/app14188208>
- Baxter, G., & Hainey, T. (2019). Student perceptions of virtual reality in higher education. *Journal of Applied Research in Higher Education*. <http://doi.org/10.1108/JARHE-06-2018-0106>
- Binh, N. T. H., Dang, T.-Q., & Nguyen, L.-T. (2024). Metaverse: The Future for Immersive Logistics and International Business Education. *Journal of Teaching in International Business*, 35(3–4), 75–107. <https://doi.org/10.1080/08975930.2024.2445861>
- Campos, E., Hidrogo, I., & Zavala, G. (2022). Impact of virtual reality use on the teaching and learning of vectors. *Frontiers in Education*, 7, <https://doi.org/10.3389/feduc.2022.965640>.
- Chen, Y. L. (2016). The Effects of Virtual Reality Learning Environment on Student Cognitive and Linguistic Development, 637–646. <http://doi.org/10.1007/s40299-016-0293-2>
- Cheng, K. H., & Tsai, C. C. (2021). Exploring the relationships among students' motivation, engagement, and learning outcomes in virtual reality learning environments. *Computers & Education*, 168, 104194.
- Chin, W.W. (2010) How to Write Up and Report PLS Analyses. In: Esposito Vinzi, V., Chin, W.W., Henseler, J. and Wang, H., Eds., *Handbook of Partial Least Squares: Concepts, Methods and Applications*, Springer, Heidelberg, Dordrecht, London, New York, 655-690. [https://doi.org/10.1007/978-3-540-32827-8\\_29](https://doi.org/10.1007/978-3-540-32827-8_29)
- Christopoulos, A., Styliou, M., Ntalas, N., & Stylios, C. (2024). The Impact of Immersive Virtual Reality on Knowledge Acquisition and Adolescent Perceptions in Cultural Education. *Information (Switzerland)*, 15(5). <https://doi.org/10.3390/info15050261>
- Chu, S. T., Hwang, G. J., & Hwang, G. H. (2023). A Goal-Oriented Reflection Strategy-Based Virtual Reality Approach to Promoting Students' Learning Achievement, Motivation and Reflective Thinking. *Sustainability (Switzerland)*, 15(4). <https://doi.org/10.3390/su15043192>
- Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd Edition). Hillsdale, NJ: Lawrence Earlbaum Associates.
- Conesa, J., Martinez, A., Mula, F., & Contero, M. (2024). Learning by Doing in VR: A User-Centric Evaluation of Lathe Operation Training. <https://doi.org/10.3390/electronics13132549>.
- Cook, M., & Lischer-Katz, Z. (2020). Practical steps for an effective virtual reality course integration. *College & Undergraduate Libraries*, 27(2–4), 210–226. <https://doi.org/10.1080/10691316.2021.1923603>
- Cooper, N., Milella, F., Pinto, C., Cant, I., White, M. & Meyer, G. (2018). The effects of substitute multisensory feedback on task performance and the sense of presence in a virtual reality environment. *PLoS ONE*, e0191846. <https://doi.org/10.1371/journal.pone.0191846>
- Dang, T. Q., Duc, D. T. V., Tran, L. H. P., & Nguyen, L. T. (2025). EXAMINING THE IMPACT OF TRUST ON CUSTOMER

INTENTION TO USE METAVERSE PAYMENTS: A NEXT-GEN TRANSACTIONS STRATEGIC OUTLOOK. *Corporate and Business Strategy Review*, 6(1), 166–177. <https://doi.org/10.22495/cbsrv6i1art16>

Dang, T.-Q., Mai, V.-T. L., Duc, D. T. V., Huynh, T. B., & Nguyen, N. T. T. (2026). A mixed methods analysis of palm payment adoption based on UTAUT2 and perceived trust. *Discover Psychology*. <https://doi.org/10.1007/s44202-025-00548-9>

Dang, T.-Q., Nguyen, L.-T., & Duc, D. T. V. (2025). Impulsive Buying and Compulsive Buying in Social Commerce: An Integrated Analysis using the Cognitive-Affective-Behavior Model and Theory of Consumption Values with PLS-SEM. *SAGE Open*, 15(2). <https://doi.org/10.1177/21582440251334215>

Dang, T.-Q., Nguyen, T.-M., Tran, P.-T., Phan, T.-T. C., Huynh, T.-B., & Nguyen, L.-T. (2025). From reality to virtuality: Unveiling Gen Z's purchasing behavior through virtual influencers in the metaverse. *Digital Business*, 5(2), 100141. <https://doi.org/10.1016/j.digbus.2025.100141>

Dang, T.-Q., Tan, G. W.-H., Aw, E. C.-X., Ooi, K.-B., Metri, B., & Dwivedi, Y. K. (2023). How to generate loyalty in mobile payment services? An integrative dual SEM-ANN analysis. *International Journal of Bank Marketing*, 41(6), 1177–1206. <https://doi.org/10.1108/IJBM-05-2022-0202>

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. *Management Science*, 35(8), 982–1003. <https://doi.org/10.1287/MNSC.35.8.982>

de Klerk, R., Duarte, A. M., Medeiros, D. P., Duarte, J. P., Jorge, J., & Lopes, D. S. (2019). Usability studies on building early-stage architectural models in virtual reality. *Automation in Construction*, 103, 104–116. <https://doi.org/10.1016/j.autcon.2019.03.009>

Ding, X., & Li, Z. (2022). A review of the application of virtual reality technology in higher education based on Web of Science literature data as an example. *Frontiers in Education*, 7. <https://doi.org/10.3389/educ.2022.1048816>

Familoni, B. T., & Onyebuchi, N. C. (2024). Augmented and virtual reality in u.s. education: A review: Analyzing the impact, effectiveness, and future prospects of ar/vr tools in enhancing learning experiences. *International Journal of Applied Research in Social Sciences*, 6(4), 642–663. <https://doi.org/10.51594/ijarss.v6i4.1043>

Fink, M. C., Eisenlauer, V., & Ertl, B. (2023). What variables are connected with system usability and satisfaction? Results from an educational virtual reality field trip. *Computers & Education: X Reality*, 3, 100043. <https://doi.org/10.1016/J.CEXR.2023.100043>

Fitrianto, I., & Saif, A. (2024). The Role of Virtual Reality in Enhancing Experiential Learning: A Comparative Study of Traditional and Immersive Learning Environments. *Vol. 2 No. 2 June 2024: International Journal of Post-Axial*. <https://doi.org/10.59944/postaxial.v2i2.300>

Foo, P. Y., Lee, V. H., Tan, G. W. H., & Ooi, K. B. (2018). A gateway to realising sustainability performance via green supply chain management practices: A PLS-ANN approach. *Expert Systems with Applications*, 107, 1–14. <https://doi.org/10.1016/j.eswa.2018.04.013>

Fornell, C., & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research*, 18(1), 39. <https://doi.org/10.2307/3151312>

Fu, Y., & Zhang, N. (2021). A Study on the Practicality of Virtual Reality Technology in the Teaching of Photography in Colleges and Universities. *2021 International Conference on Internet, Education and Information Technology (IEIT)*, 6, 481–486. <https://doi.org/10.1109/ieit53597.2021.00113>

Gefen, D., Karahanna, E., & Straub, D. (2003). Trust and TAM in Online Shopping: An Integrated Model. *MIS Quarterly*, 27 (1), 51.

Goertz, L., Hagenhofer, T., Fehling, C. D. (2021). Planning the Use of Augmented and Virtual Reality for Vocational Education and Training (E. Hanau & Federal Institute for Vocational Education and Training (BIBB), Eds.). Federal Institute for Vocational Education and Training (BIBB).

- Guerra-Tamez, C. (2023). The Impact of Immersion through Virtual Reality in the Learning Experiences of Art and Design Students: The Mediating Effect of the Flow Experience. *Educ. Sci.* 2023, 13, 185. <https://doi.org/10.3390/educsci13020185>.
- Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (2019). *Multivariate Data Analysis*. In Book (Vol. 87, Issue 4).
- Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2021). Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R. 1–40. <https://doi.org/10.1007/978-3-030-80519-7>
- Hair, J., Hollingsworth, C. L., Randolph, A. B., & Chong, A. Y. L. (2017). An updated and expanded assessment of PLS-SEM in information systems research. *Industrial Management and Data Systems*, 117(3), 442–458. <https://doi.org/10.1108/IMDS-04-2016-0130>
- Hameed, A., & Perkis, A. (2024). Authenticity and presence: defining perceived quality in VR experiences. *Frontiers in Psychology*, 15. <https://doi.org/10.3389/fpsyg.2024.1291650>
- Hamilton, D., McKechnie, J., Edgerton, E., & Wilson, C. (2021a). Immersive virtual reality as a pedagogical tool in education: a systematic literature review of quantitative learning outcomes and experimental design. *Journal of Computers in Education*, 8(1), 1–32. <https://doi.org/10.1007/s40692-020-00169-2>
- Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, 43(1), 115–135. <https://doi.org/10.1007/S11747-014-0403-8>
- Hewei, T. (2022). Factors affecting clothing purchase intention in mobile short video app: Mediation of perceived value and immersion experience. *PLoS ONE*, e0273968. <https://doi.org/10.1371/journal.pone.0273968>
- Huang, H., & Lee, C. (2019). Factors affecting usability of 3D model learning in a virtual reality environment. Pages 848-861 <https://doi.org/10.1080/10494820.2019.1691605>.
- Hussein, M., & Nätterdal, C. (2015). *The Benefits of Virtual Reality in Education: A Comparison Study* (By Jan-Philipp Steghöfer, University of Gothenburg, & Chalmers University of Technology).
- Ibodullayev, S. N., & Bahromov, A. A. (2020). A Variety of Virtual Reality Implementations For Creative Learning and 5 Ways to Implement Virtual Reality in The Learning Process. *International Journal of Engineering and Information Systems (IJEAIS)*. Pages 60-63.
- Jensen, L., and Konradsen, F. (2018). A review of the use of virtual reality headmounted displays in education and training. *Educ Inf Technol (Dordr)* 23, 1515–1529. <https://doi.org/10.1007/s10639-017-9676-0>
- Kamińska, D., Zwoliński, G., & Laska-Leśniewicz, A. (2022). Usability Testing of Virtual Reality Applications—The Pilot Study. *Sensors*, 22(4). <https://doi.org/10.3390/s22041342>
- Kanade, S. G., & Duffy, V. G. (2024). Exploring the effectiveness of virtual reality as a learning tool in the context of task interruption: A systematic review. *International Journal of Industrial Ergonomics*, 99, 103548. <https://doi.org/10.1016/j.ergon.2024.103548>
- Kock, N. (2015). Common method bias in PLS-SEM: A full collinearity assessment approach. *International Journal of e-Collaboration*, 11(4), 1-10.
- Lackey, S. J., Salcedo, J. N., Szalma, J. & Hancock, P. (2016). The stress and workload of virtual reality training: The effects of presence, immersion and flow. *Ergonomics*, 1060–1072. <http://doi.org/10.1080/00140139.2015.1122234>
- Le, T.-T., Lin, P.-T., Duc, D. T. V., Dang, T.-Q., & Nguyen, L.-T. (2025). Optimizing and restructuring resources for sustainable firm performance in the AI era: the role of dynamic capabilities and circular manufacturing. *Sustainable Futures*, 10, 101441. <https://doi.org/10.1016/j.sftr.2025.101441>
- Lee, H., Jung, T. H., Dieck, M. T. & Chung, N. (2020). Experiencing immersive virtual reality in

- museums, 57, 103229.  
<https://doi.org/10.1016/j.im.2019.103229>
- Li, P., Fang, Z., Jiang, T. (2022). Research Into improved Distance Learning Using VR Technology. *Frontiers in Education*, 7, <https://doi.org/10.3389/educ.2022.757874>.
- Liao, C. H. (2024). Exploring perceived learning effectiveness in virtual reality health communication through the lens of construal level theory. *BMC Public Health*, 24(1). <https://doi.org/10.1186/s12889-024-19827-6>
- Lin, X. P., Li, B. B., Yao, Z. N., Yang, Z., Zhang, M. (2024). The impact of virtual reality on student engagement in the classroom—a critical review of the literature. In *Frontiers in Psychology* (Vol. 15). Frontiers Media SA, <https://doi.org/10.3389/fpsy.2024.1360574>.
- Loh, X. M., Lee, V. H., Tan, G. W. H., Ooi, K. B., & Dwivedi, Y. K. (2021). Switching from cash to mobile payment: what's the hold-up? *Internet Research*, 31(1), 376–399. <https://doi.org/10.1108/INTR-04-2020-0175>
- Makransky, G., & Lilleholt, L. (2018). A Structural Equation Modeling Investigation of the Emotional Value of Immersive Virtual Reality in Education. *Educational Technology Research and Development* 66(3). <http://doi.org/10.1007/s11423-018-9581-2>
- Makransky, G., Borre-Gude, S. & Mayer, R. (2019). Motivational and cognitive benefits of training in immersive virtual reality based on multiple assessments, 691–707. <http://dx.doi.org/10.1111/jcal.12375>
- Mallek, F., Mazhar, T., Shah, S. F. A., Ghadi, Y. Y. & Hamam, H. (2024). A review on cultivating effective learning: synthesizing educational theories and virtual reality for enhanced educational experiences. <https://doi.org/10.7717/peerj-cs.2000>
- Marikyan, D., & Papagiannidis, S. (2023) *Technology Acceptance Model: A review*. In S. Papagiannidis (Ed), [TheoryHub Book](https://open.ncl.ac.uk). Available at <https://open.ncl.ac.uk> / ISBN: 9781739604400.
- Marougkas, A., Troussas, C., Krouska, A., & Sgouropoulou, C. (2024). How personalized and effective is immersive virtual reality in education? A systematic literature review for the last decade. *Multimedia Tools and Applications*, 83(6), 18185–18233. <https://doi.org/10.1007/s11042-023-15986-7>
- Molina-Carmona, R., Pertegal-Felices, M. L., Jimeno-Morenilla, A., & Mora-Mora, H. (2018). Assessing the impact of virtual reality on engineering students. In J. Garcia-Penalvo (Ed.), *Proceedings of the Sixth International Conference on Technological Ecosystems for Enhancing Multiculturality*. <https://doi.org/10.1108/978-1-78756-555-520181013>
- Nesenbergs, K., Abolins, V., Ormanis, J., & Mednis, A. (2020). Use of Augmented and Virtual Reality in Remote Higher Education: A Systematic Umbrella Review. *Education Sciences*, 11(1), 8. <https://doi.org/10.3390/educsci11010008>
- Ng, N. F., Schafer, R. J., Simone, C. M., & Osman, A. M. (2020). Perceptions of Brain Training: Public Expectations of Cognitive Benefits from Popular Activities. *Frontiers in Human Neuroscience*, 14. <https://doi.org/10.3389/fnhum.2020.00015>
- Nguyen, L.-T., Phan, T.-T. C., & Dang, T.-Q. (2025). The Power of Interactive Mobile Advertising: How Self-brand Congruity Shapes Brand Engagement in Self-concept. *Journal of Creative Communications*. <https://doi.org/10.1177/09732586251359718>
- Pellas, N., Dengel, A., Christopoulos, A. A Scoping Review of Immersive Virtual Reality in STEM Education. *IEEE Trans. Learn. Technol.* 2020, 13, 748–761.
- Putranto, J. S., Heriyanto, J., & Khusuma, A. (2023). Implementation of virtual reality technology for enhancing sports education: A systematic review. *Procedia Computer Science*. <https://doi.org/10.1016/j.procs.2022.12.139>
- Rangarajan, V., Badr, A. S., & De Amicis, R. (2024). Evaluating Virtual Reality in Education: An Analysis of VR through the Instructors' Lens. *Multimodal Technologies and Interaction*, 8(8), 72. <https://doi.org/10.3390/mti8080072>
- Sagnier, C., Loup-Escande, E., Lourdeaux, D., Thouvenin, I., & Vallery, G. (2020). User

- Acceptance of Virtual Reality: An Extended Technology Acceptance Model. *International Journal of Human-Computer Interaction*, 36(11), 993–1007. <https://doi.org/10.1080/10447318.2019.1708612>
- Serna-Mendiburu, G. M., & Guerra-Tamez, C. R. (2024). Shaping the future of creative education: the transformative power of VR in art and design learning. *Frontiers in Education*, 9. <https://doi.org/10.3389/educ.2024.1388483>
- Shin, D. & Biocca, F. (2018). Exploring immersive experience in journalism. *New Media & Society*, Volume 20, Issue 8, 2800–2823. <https://doi.org/10.1177/1461444817733133>
- Shin, D. (2019). How does immersion work in augmented reality games? A user-centric view of immersion and engagement. *Information, Communication & Society*, 1212–1229. <https://doi.org/10.1080/1369118X.2017.1411519>
- Soper, D. S. (2024). A-priori Sample Size Calculator for Structural Equation Models [Software]. Available from <https://www.danielsoper.com/statcalc>.
- Sukirman, S., Farhana, L., Ibarim, M., Soh Said, C., & Murtiyasa, B. (2024). International Journal of Serious Games Development and Usability Testing of a Virtual Reality Game for Learning Computational Thinking. *International Journal of Serious Games I*, 11(3). <https://doi.org/10.17083/ijsg.i11v3.670>
- Sunday, K., Oyelere, S. S., Agbo, F. J., Aliyu, M. B., Balogun, O. S., & Bouali, N. (2023). Usability Evaluation of Imikode Virtual Reality Game to Facilitate Learning of Object-Oriented Programming. *Technology, Knowledge and Learning*, 28(4), 1871–1902. <https://doi.org/10.1007/s10758-022-09634-6>
- Tan, G. W. H., & Ooi, K. B. (2018). Gender and age: Do they really moderate mobile tourism shopping behavior? *Telematics and Informatics*, 35(6), 1617–1642. <https://doi.org/10.1016/j.tele.2018.04.009>
- Thomann, H., Zimmermann, J., & Deutscher, V. (2024). How effective is immersive VR for vocational education? A randomized trial. *Computers & Education*. <https://doi.org/10.1016/j.compedu.2024.105127>
- Tien, P. C. T., Luan, N. T., & Tri, D. Q. (2023). Exploring the brand experience of Korean brands on customer interactions in Ho Chi Minh City, Vietnam: non-linear structural equation modelling approach. In T. Van Tieng (Ed.), *Kỷ yếu hội thảo khoa học quốc tế Việt – Hàn 2023* (pp. 276–289). Information and Communications Publishing House; ZBW - Leibniz Information Centre for Economics. <https://hdl.handle.net/10419/278122>
- Tran, H. T. P. (2024). Retrieved from Lý luận chính trị: <https://lyluanchinhtri.vn/phat-trien-nguon-nhan-luc-dap-ung-yeu-cau-cong-nghiep-hoa-hien-dai-hoa-dat-nuoc-hien-nay-6305.html>
- Vasanthi, R. K., Li, B. C. J., Purushothaman, V. K., A, K., Chinnusamy, S., Karuppaiyan, R. K., & Subbarayalu, A. V. (2023). Perceived usefulness and ease of using virtual reality during physiotherapy—A cross-sectional survey from physiotherapists perspective. *Electronic Journal of General Medicine*, 20(6), em530. <https://doi.org/10.29333/ejgm/13519>
- Violante, M. G., & Vezzetti, E. (2015). Virtual interactive e-learning application: an evaluation of the student satisfaction, 72–91. <http://doi.org/10.1002/cae.21580>
- Vishwakarma, P., Mukherjee, S. & Datta, B. (2020). Travelers’ intention to adopt virtual reality: A consumer value perspective, 100456. <https://doi.org/10.1016/j.jdmm.2020.100456>
- Wang, X., Young, G. W., Plechatá, A., & Wilkinson, R. (2023). Utilizing virtual reality to assist social competence development in higher education. *Computers & Education*. <https://doi.org/10.1016/j.compedu.2023.104815>
- Weerasinghe, S. & Hindagolla, M. (2017). Technology Acceptance Model in the Domains of LIS and Education: A Review of Selected Literature.
- Westland, J. C. (2010). Lower bounds on sample size in structural equation modeling. *Electronic Commerce Research and Applications*, 476–487.
- Wong, E. Y., Hui, R. T., & Kong, H. (2023). Perceived usefulness of, engagement with, and

effectiveness of virtual reality environments in learning industrial operations: the moderating role of openness to experience. *Virtual Reality*, 27(3), 2149–2165.

<https://doi.org/10.1007/s10055-023-00793-0>

Xu, X., Kang, J. & Yan, L. (2022). Understanding embodied immersion in technology-enabled embodied learning environments, 103–119.

<http://doi.org/10.1111/jcal.12594>

Yang, C., Zhang, J., Hu, Y., Yang, X., Chen, M., Shan, M., & Li, L. (2024). The impact of virtual reality on practical skills for students in science and engineering education: a meta-analysis.

*International Journal of STEM Education*, 11(1).

<https://doi.org/10.1186/s40594-024-00487-2>

Ye, Q., Zhou, R., Anwar, M. A., Siddiquei, A. N., Hussain, S., & Asmi, F. (2022). Virtual reality- based learning through the lens of eudaemonic factors: Reflective thinking as a game changer. *Thinking Skills and Creativity*,

45, 101103.

<https://doi.org/10.1016/J.TSC.2022.101103>

Young, G., Stehle, S., Walsh, B., & Tiri, E. (2020). Exploring Virtual Reality in the Higher Education Classroom: Using VR to Build Knowledge and Understanding. *JUCS - Journal of Universal Computer Science*, 26(8), 904–928.

<https://doi.org/10.3897/jucs.2020.049>

Yusof, A. A., Adnan, A. H. M., Kamal, N. N. M., Kamal, M. A. M., & Ahmad, M. K. (2019). Education 4.0 Immersive Learning with Spherical Videos (360°) and Virtual Reality (VR) Experiences. ISBN number: 978-967-17324-4-1

Zhang, X., Jiang, S., de Pablos, P. O., Lytras, M. D. & Sun, Y. (2017). How virtual reality affects perceived learning effectiveness: A task–technology fit perspective, 548–556.

<http://dx.doi.org/10.1080/0144929X.2016.1268647>