

# College Students' Continuing Willingness to Use Virtual Simulation Learning Systems: Empirical Evidence from China

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**Abstract** With the initiation of the National Virtual Simulation Experimental Teaching Project in 2018, educational institutions in China have recognized the significance of virtual simulation technology in reforming traditional teaching methods and fostering innovative talent cultivation models. Within the realm of higher education in China, motivating students to sustain their utilization of Virtual Simulation Learning Systems (VSLs) has become a significant challenge. This article builds upon an assessment of the development status of VSLs in Chinese higher education and draws upon previous studies to construct a model comprising three dimensions: perceived quality, perceived value, and social influence, with the aim of predicting students' enduring willingness to engage with VSLs. To achieve this objective, a structural modeling analysis approach is employed to explore the interrelationships among the constructs under investigation, while a survey questionnaire is utilized to collect relevant data. The sample population consists of 274 college students from diverse disciplinary fields in China, including Science, Technology, Engineering, and Mathematics (STEM) and Humanities, Arts, and Social Sciences (HASS). The findings reveal that perceived value significantly influences students' willingness to participate, with perceived benefits exerting a greater impact than perceived costs. Furthermore, the overall quality of the VSLs, encompassing aspects such as software quality, instructional design quality, and virtual simulation quality, holds substantial influence over students' perceived value. Additionally, societal factors such as course scheduling and recommendations from teachers exhibit a positive impact on students' intention to continue using VSLs. Building upon these findings, the article presents relevant recommendations aimed at enhancing students' sustained utilization of VSLs.

**Keywords** Virtual Simulation Learning Systems (VSLs),

e-learning, perceived value, perceived quality, social influence

## 1 Introduction

Virtual Simulation Learning Systems (VSLs) play a crucial role in the digital transformation of education, enabling technology-driven approaches and fostering personalized and inclusive learning experiences for students. As a result, countries worldwide are placing significant emphasis on development, promotion, and application of VSLs. According to *Fortune Business Insights*, the global virtual reality market is projected to experience substantial growth, with an estimated increase from 4.4 billion USD in 2023 to 28.7 billion USD by 2030, reflecting a compound annual growth rate of 30.7% (Fortune Business Insights, 2023).

A noteworthy initiative in this domain is the financial support provided by the Andrew Foundation to establish Harvard University's (2020) LabXchange platform, which features 24 virtual simulation laboratories and a vast array of learning resources sourced from 150 renowned universities and educational technology companies. The establishment of LabXchange signifies the commitment to advancing virtual simulation learning and underscores its importance attributed to development. Massachusetts Institute of Technology (MIT)'s AIM Photonics Academy has also made significant strides in this field by creating a virtual simulation laboratory that allows students to explore photon devices and circuit modeling at the micron level. This laboratory seamlessly integrates into an online course on PIC chip design, providing students with hands-on experience and practical knowledge (Saini et al., 2019). Similarly, prestigious institutions like the University of Cambridge and the University of Oxford have made notable advancements in the realm of virtual simulation medical training systems (Cambridge University Hospitals NHS Foundation Trust, 2022; OMS, 2023). These institutions have recognized the potential of virtual simulation in enhancing medical education and have dedicated resources to develop cutting-edge

solutions in this area.

Acknowledging the growing interests and demands for virtual simulation learning, leading educational publishers such as McGraw Hill are introducing relevant products to cater to this need. For instance, McGraw Hill offers a comprehensive range of over 135 virtual simulation laboratories covering various disciplines, including anatomy and physiology, biology, nutrition, chemistry, and nursing. These laboratories serve as valuable tools for teachers to augment traditional classroom settings, enabling flexible teaching arrangements and personalized assessments.

In conclusion, the global focus on virtual simulation learning systems underscores their critical role in transforming traditional education and meeting the demands of a technology-driven era. Through significant investments, collaborations, and innovative solutions, countries and institutions are paving the way for an immersive and effective learning experience for students worldwide.

China has made significant investments in virtual simulation learning systems in higher education. In 2013, the Ministry of Education of the People's Republic of China (MoE of China) introduced a policy to establish national centers for virtual simulation laboratory teaching. This policy is a part of the "Ten-Year Plan for Educational Informatization (2011–2020)" and aims to encourage higher education institutions to explore the use of virtual simulation in teaching. Since then, China has developed a wide range of virtual simulation teaching resources. In 2017, the MoE of China issued another policy to promote the collaborative construction and sharing of virtual simulation resources, resulting in the creation of the iLab-X service platform. This platform serves as a repository for national projects in virtual simulation laboratory teaching, and brings together higher education institutions from across the country to develop and implement more virtual simulation-based courses. As of the end of 2023, the platform hosts over 3,500 courses in 11 major disciplines, with a record of over 15 million learning visits (iLab-X, 2023). Each course on the platform provides essential supplementary materials for virtual simulation learning, including textbooks, presentations, references, and lab manuals. To ensure high-quality development, the MoE of China has entrusted leading higher education publishers with peer review and technical support for all courses.

The acceptance and successful implementation of new e-learning technologies and systems are intrinsically linked to the willingness of students to embrace them. Even the most advanced platforms cannot fulfill their potential if students are reluctant to utilize them. Hence, when promoting e-learning systems, it is imperative to address a fundamental inquiry: Which factor has a significant impact on students' motivation to sustain their engagement in virtual simulation learning? Drawing on prior research in this domain, the present studies focus

on three pivotal dimensions—perceived quality, perceived value, and social influence—and endeavor to examine their correlations with students' willingness to participate in VSLs through a comprehensive questionnaire survey.

## 2 Theoretical Background

### 2.1 | Diffusion of Innovation Theory

Diffusion of innovation theory explains how, why, and at what rate innovations spread. Rogers et al. (2014) identify four critical factors, namely perceived features of innovation, communication channels, time, and the social system. They propose five key attributes that influence adoption decisions: relative advantage, compatibility, complexity, and observability. People may reject an innovation if they perceive it as too complex to use, incompatible with their needs, or inferior to its counterparts. They may also hesitate if they were denied the chance to experience or witnessing it in use. Therefore, it is important to improve communication channels. This is based on the assumption that people with strong innovation acceptance are more likely to communicate their experiences and opinions. And this may influence others' adoption decisions. On the other hand, the influence of social systems is also important. Rogers et al. (2014) define it as sets of interrelated units influencing adoption decisions through common goals and normative systems. They can be the government, the mass media, and the institutions of communities in which adopters engage. At a micro level, the influence of the social system depends on the strength of an individual's social ties and her/his distance from opinion leaders (Strang & Soule, 1998). At last, since the diffusion of innovation theory provides valuable insights into both the technical and social dimensions of the progress of innovation adoption, it has gained some acceptance in the field of e-learning.

### 2.2 | E-Learning System Quality

E-learning systems are information systems (ISs) designed for educational purposes. The ISs success theory proposed by DeLone and McLean (2003) suggests that adoption rates increase when users perceive high quality of the ISs. And it depends on what services users receive from ISs and how capable the software is at delivering them. For example, the ISO/IEC 9126-1 Software Product Quality Model emphasizes technical capability and usability from the users' perspective. Santos (2023) says e-service quality depends on the factors—the design of IS products as well as its actual service effects. He proposes six service quality features (i.e., reliability, efficiency, support, communication, security, and incentives) and six for IS software (i.e., ease of use, appearance, linkage, structure, layout, and content). For instance, users may

be more willing to use an IS when it allows them to get useful content quickly and easily (De Ruyter et al., 2001; Yen & Lu, 2008).

The growth of online education raises interests in its service quality. It turns out that a particular focus on instructional design quality is required. Ozkan and Koseler (2009) propose an e-learning system quality model highlighting learning model and tutorial quality. Al-Fraihat et al. (2020) say that it revolves around attributes like assessment material and diversity of learning styles. And some studies find that it affects students' learning willingness (Pham et al., 2018; Pham et al., 2019; Wong & Huang, 2011).

### 2.3 | Perceived Value

A new e-learning technology or e-learning system may gain rapid and repeated adoption when it meets users' needs or demonstrates positive results (Bandura, 1986; Rogers, 2014). However, users may also hesitate or refuse it if it costs too much. In this regard, users often need to weigh the benefits and losses before deciding whether to adopt it. Perceived value refers to the result of this subjective assessment (Lovelock, 2000; Zeithaml, 1988). It has shown correlations with students' willingness to use e-learning systems consistently (Lew et al., 2019; Li et al., 2012; Liaw & Huang, 2013; Lin & Wang, 2012; Park, 2009; Rajeh et al., 2021). In the business area, Woodruff (1997) considers perceived value a better predictor of continuous usage intention than perceived quality.

Eccels and Wigfield develop a taxonomy of perceived value to facilitate education assessment. It takes into account cost elements, as opposed to previous assessments that only consider perceived benefits (such as PERVAL). Perceived benefits contain three dimensions: (1) utility, the extent to which e-learning systems are aligned with established learning goals; (2) attainment, the extent to which e-learning systems meet the needs of students to develop personalities and social identities; (3) interest, the extent to which e-learning systems stimulate students' learning interests and enjoyments. Perceived costs are also divided into three dimensions: (1) efforts cost, the amount of efforts required and whether it is worthwhile; (2) emotional cost, negative emotions caused by struggling or failing in the learning tasks; (3) opportunity cost, the extent to which focusing exclusively on one learning task detracts from students' abilities or time to perform other valued tasks. This perceived value framework has supported several empirical studies on the acceptance of e-learning (Ball et al., 2019; Gavarkovs et al., 2022; Jiang et al., 2022; Mondri, et al., 2007; Nguyen et al., 2014; Pereira et al., 2015; Wu et al., 2016).

## 3 Research Model and Hypothesis

According to the theoretical foundations and relevant research findings mentioned above, we propose a three-dimensional model (see Figure 1) to conduct the following study.

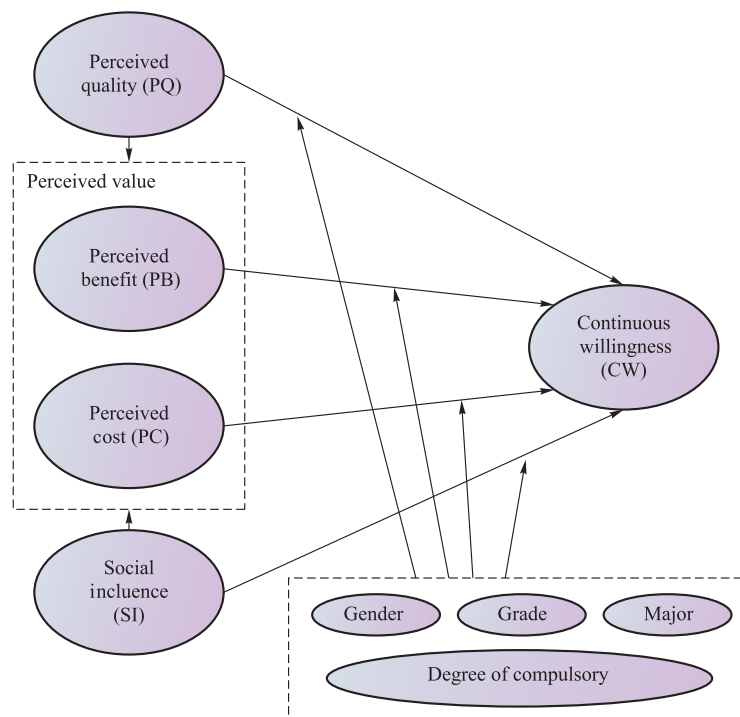


Figure 1 Research Model for This Study

### 3.1 | Perceived Quality

VSLs are designed to immerse students in a rationally configured environment in which they can learn through simulations. As a result, the VSLs quality assessment should consider both the general quality of the e-learning system as well as the characteristics of the virtual simulation. Perceived quality (PQ) is defined as the sum of software quality, instructional design quality, and virtual simulation quality, and hypothesized that PQ is positively related to students' continuous willingness to use VSLs.

Our primary concern for the software quality rests on whether the VSLs respond to students operations promptly and are compatible with the students' hardware and software. This determines whether or not the virtual simulation can be presented successfully. Instructional design quality is measured by asking students if they feel learning tasks in the VSLs are scientifically sound. The quality of virtual simulations is evaluated on the basis of whether students can effectively interact and feel immersed in the simulation environment.

*H1:* PQ is positively related to students' continuous willingness (CW) to use VSLs.

### 3.2 | Perceived Value

A number of studies have demonstrated the benefits of virtual simulation-based learning. These include helping students improve their operational skills (Dubovi et al., 2017; Jou & Wang, 2013; Smith & Hamilton, 2015) and problem-solving ability (Araiza-Alba et al., 2021; Becker et al., 2005; Gunawan et al., 2017; Rogers, 2011; Yuliati et al., 2018). Besides, VSLs may also enhance students' learning interests because of their unique presentation styles (Huang et al., 2013; Shi & Liang, 2012; Verkuy et al., 2018). On this basis, some teachers have included outcomes of learning with VSLs in their course assessment criteria. This implies that students may be able to improve their grades by continuously using VSLs.

Perceived benefit (PB) is defined as the extent to which students feel that VSLs improve their learning performance, personal ability, and learning interest assuming that it is hypothesized positively related to students' continuous willingness to use VSLs.

*H2:* PB is positively related to students' CW to use VSLs.

For the cost part, it undoubtedly takes time and energy to complete learning tasks on VSLs. And students may feel anxiety while learning with VSLs (Su, 2016). Meanwhile, Chinese students are exposed to an increasing variety of learning opportunities and tasks. They may have to sacrifice or abandon other valued learning tasks to make room for VSLs, especially when VSLs are made mandatory. Thus, perceived cost (PC) is defined as the sum of effort costs, emotional costs, and

opportunity costs as proposed in Eccels and Wigfield's perceived value framework assuming that it is negatively related to students' continuous willingness to use VSLs.

*H3:* PC is negatively related to students' CW to use VSLs.

Studies have confirmed that perceived value can mediate between perceived quality and continuous willingness to use a product (Kettinger & Smith, 2009; Li & Shang, 2020). This naturally prompts us to ask whether perceived quality affects students' perceived value of VSLs and in turn affects students' intention to continue using them? This led to following hypotheses:

*H4:* PQ is positively related to PB.

*H5:* PQ is negatively related to PC.

*H6:* PB has mediating effects between PQ and students' CW to use VSLs.

*H7:* PC has mediating effects between PQ and students' CW to use VSLs.

### 3.3 | Social Influence

A variety of social influences may influence students' CW to use VSLs. The most common groups are teachers and peers. Teachers decide whether or not to incorporate VSLs into course design and assessment. They own the authority to require or recommend VSLs, and students should consider their opinions. Peer influence occurs in two ways: First, peers may share insights and experiences concerning the use of VSLs, and second, peer competition may create pressure on students to utilize VSLs. It has been observed that the more teachers and peers support an e-learning technology or system, the more students will want to use it. Furthermore, students may also be influenced by social media (Alghizzawi et al., 2019; Salloum et al., 2021). Thus, an increasing number of schools promote virtual simulation learning systems through campus media to increase student awareness and use of such systems.

Social influence (SI) is defined as the sum of teacher influence, peer influence, and media influence. Teacher influence is measured by students' perception that teachers advocate VSLs. Peer influence is students' perception that their peers believe they should use VSLs and fear falling behind. Media impact is the extent to which VSLs are publicized and promoted in campus media. We assume that their combination to positively affects students' continuous willingness to use VSLs.

*H8:* SI is positively related to students' CW to use VSLs.

Social influence may also affect perceived value because the latter heavily depends on the social context where an e-learning system is used (Sheth et al., 1991; Sweeney & Soutar, 2001). In this study, SI may raise students' awareness of the benefits of learning with VSLs when teachers, peers, and campus media mention them.

In this situation, students may be suggested to take on additional learning tasks or feel nervous about using an unfamiliar system at the same time. Therefore, we hypothesize that social influence positively impacts PB as well as PC, and in turn, affects students' continuous willingness to use VSLs.

*H9*: SI is positively related to PB.

*H10*: SI is negatively related to PC.

*H11*: PB has mediating effects between SI and students' CW to use VSLs.

*H12*: PC has mediating effects between SI and students' CW to use VSLs.

Additional individual differences predictors are also examined in our models to see if they moderated the effect of different variables on students' continuous willingness to use VSLs, including gender, grade, major, and compulsory degree as Venkatesh et al. (2003) consider in the original UTAUT model.

## 4 Methodology

### 4.1 | Procedure and Sample Profile

In 2021 March, we spread an online questionnaire with personal channels and the help of several college teachers. At the beginning, participants were informed of the purpose of this study and required to read an introduction to VSLs. To ensure sample validity, we included a question asking students if they had experience with VSLs. Only participants who answered "yes" were allowed to answer the subsequent questions. Finally, 274 questionnaires met this criterion in accordance with the automated count. 46% of these college students were males, 64.6% from STEM majors (i.e., science, technology, engineering, and mathematics), and 86.1% from undergraduates (i.e., college freshmen, sophomores, and juniors) (see Table 1). School-run VSLs ( $N = 229$ , 83.6%) turned out to be the most popular delivery channels. Teachers' promotion of VSLs is considerable: 41.2% made VSLs mandatory and 42.7% recommended. However, 86.1% of experienced respondents learned with VSLs for less than 2 hours a week.

### 4.2 | Measures

The questionnaire contained three parts: demographic question, learning experience with VSLs, and the structural modeling. The structural modeling included PQ, PB, PC, SI, and students' CW to use VSLs. Each statement of these five constructs was measured with a five-point Likert scale with  $-2 =$  strongly disagree to  $2 =$  strongly agree. All of them were presented in Chinese and reviewed for professionalism, wording, and readability by two e-learning specialists and several students representatives from different majors.

**Table 1** Sample Profile ( $N = 274$ )

Items	Scale	Frequency	Percentage (%)
Gender	Male	126	46.0
	Female	148	54.0
Grade	Undergraduate	236	86.1
	Graduate	38	13.9
Major	STEM	177	64.6
	HASS	97	35.4
Delivery channel	State-run	44	16.1
	School-run	229	83.6
Option	Commercial products	56	20.4
	Compulsory	113	41.2
	Recommended	117	42.7
	No requirement	44	16.1
Duration of study	< 1 h/week	93	33.9
	1–2 h/week	124	45.3
	3–4 h/week	46	16.8
	$\geq 5$ h/week	11	4.01
Learning purpose	Pre-class learning	128	46.7
	In-class practice	163	59.5
	After-class practice	154	56.2
	Pre-exam review	70	25.5
VR/AR	Yes	84	30.7
	No	190	69.3

*Note.* STEM = science, technology, engineering, and mathematics; HASS = humanity, arts, and social science.

### 4.3 | Data Analysis

Structural equation modeling (SEM) can be more effective in finding the "best fitting model" than the first-generation techniques (e.g., principal components analysis, factor analysis, and multiple regression) (Chin, 1998). To conduct a SEM, a sample size of over 200 is acceptable (Kline, 2023) and 10 samples per item would be ideal (Kyriazos, 2018). This study has 20 measuring items, meaning the sample is adequate in terms of both criteria.

Following suggestions by Hair et al. (2019), we conducted a two-step SEM test. Testing the measurement. The reliability of the questionnaire was examined by two parameters. The standardized factor loading (SFL) of each item was supposed to be above 0.7 (Hulland, 1999). Composite reliability (CR) measured the internal consistency of items loading on the latent variable. It was calculated by formula suggested by Netemeyer (2003) and was supposed to be above 0.7. The validity of the questionnaire was also estimated by two parameters. Convergent validity was estimated by the average variance extracted (AVE) of each latent variable which was supposed to be above 0.5. Discriminant validity describes the extent to which the items does not reflect other variables, which was examined by comparing the square root of AVE for each construct was greater than its correlations with other constructs (Fornell & Larcker, 1981). The degree of model fit describes how well the implied model covariance matrix matches the sample covariance matrix. The acceptable threshold of selected criteria is shown in Table 2.

**Table 2** Parameters for Measurement Model Test

Parameter	Threshold	
SFL	> 0.7	
Composite reliability	> 0.7	
AVE	> 0.5	
Fit of model	$\chi^2/df$	< 3
	CFI	> 0.9
	SRMR	< 0.08
	RMSEA	< 0.08
	GFI	> 0.8
	AGFI	> 0.8
	NFI	> 0.9

Note. CFI = comparative fit index; SRMR = standardized root mean square residual; RMSEA = root mean square error of approximation; GFI = good-of-fit index; AGFI = adjust goodness of fit index; NFI = normed fit index (same as follows).

After a satisfactory measurement model was obtained, we tested the structural model with the maximum likelihood method. We first examined the structural model path coefficients to see whether the three main hypothesized dimensions (i.e., perceived quality, perceived value, and social influence) directly affected students' willingness. Then we examined the mediation effect and moderation effect were examined.

The mediation effect was intended to explain how the impacts of a latent variable came to be. It could only be discussed if the potential moderating variable was significantly related to both the independent and dependent variables. Once the criteria were met, we performed both bias-corrected bootstrapping and percentile bootstrapping at a 95% confidence interval with 1,000 bootstrap samples (Felsenstein, 1985). Indirect effect is measured by the confidence intervals between the lower and upper bounds. The mediation effect exists if the indirect effect turns out to be significant.

Moderate effect occurs when the relationship between two variables between a third variable, which is therefore referred to as the moderator. We conducted the multi-group analysis to examine potential moderators (i.e., gender, grade, major, and compulsory degree of VSLs usage). It started with a relatively unconstrained model in which model parameters for each group were estimated separately and no equality constraints were imposed. Then a constrained model was estimated where the path estimates of interest was constrained to be invariant across both groups. A significant chi-square difference between the two models indicated moderation effects (Hair, 2019).

## 5 Results

### 5.1 | Descriptive Statistics

Following Byrne's (2001) recommendations that skewness and kurtosis should be within |3| and |10| respectively,

data in this study were regarded normal with skewness ranging from  $-0.08$  to  $-0.57$  and kurtosis from  $-0.13$  to  $0.6$ .

### 5.2 | Test of the Measurement Model

As shown in Table 3, SFL of items ranges from  $0.77$  to  $0.95$ . AVE of each latent construct ranges from  $0.65$  to  $0.83$ , and CR ranges from  $0.86$  to  $0.98$ . This revealed an acceptable reliability of items.

**Table 3** Results of Reliability and Convergent Validity of Items

Item	Question content	$\lambda$
CW (AVE = 0.83; CR = 0.94)		
CW1	I'd like to continue learning with VSLs.	0.89
CW2	I'd like to continue learning with VSLs voluntarily.	0.94
CW3	I'd like to recommend your peers to continue learning with VSLs.	0.90
PB (AVE = 0.79; CR = 0.94)		
PB1	Using VSLs helps me to improve my academic achievements.	0.89
PB2	Using VSLs helps me to practice my skills.	0.88
PB3	Using VSLs helps me to improve my problem-solving capability.	0.88
PB4	Using VSLs stimulates my learning interest.	0.90
PC (AVE = 0.79; CR = 0.94)		
PC1	Learning with VSLs is effort-consuming.	0.83
PC2	Learning with VSLs makes me anxious and less self-confident.	0.83
PC3	Learning with VSLs delays other important learning tasks.	0.95
SI (AVE = 0.65; CR = 0.88)		
SI1	My teacher wants me to study with VSLs.	0.77
SI2	Many of my classmates feel that they should use VSLs for learning.	0.87
SI3	Many students are using VSELS, I will fall behind if I don't use it.	0.79
SI4	VSELS has been promoted and advocated by the campus media.	0.79
PQ (AVE = 0.78; CR = 0.95)		
PQ1	VSLs responds to my operation timely.	0.85
PQ2	VSLs is compatible with my hardware and software devices.	0.82
PQ3	Learning tasks in the VSELS are scientifically and rationally configured.	0.86
PQ4	VSLs simulates objects and scenarios to match the real situation.	0.86
PQ5	VSLs provides the right opportunity to interact with the virtual scene.	0.86
PQ6	I can get timely technical assistance on the installation and operation of VSLs.	0.78

Note.  $\lambda$  = SFL; CR = composite reliability.

As shown in Table 4, the square of AVE of each latent construct (i.e., PB, PC, PQ, CW, and SI) was greater than its correlation with others, which demonstrated good discriminant validity. The measurement model also fitted the data well ( $\chi^2/df = 2.3$ ; CFI = 0.96; SRMR = 0.36; GFI = 0.89; AGFI = 0.85; NFI = 0.93).

**Table 4** Results of Discriminant Validity

	SI	PQ	PC	PB	CW
SI	0.81				
PQ	0.77	0.88			
PC	0.42	0.39	0.84		
PB	0.80	0.82	0.37	0.89	
CW	0.70	0.68	0.22	0.76	0.91

### 5.3 | Test of the Structural Model

As seen in Table 5, perceived quality only affected perceived benefits ( $\beta_{PQ \rightarrow PB(+)} = 0.43, p < 0.001$ ), which supported *H4* and implied that neither *H1* nor *H5* is supported. And it is meaningless to test mediating effects because perceived quality did not affect students' willingness to use VSLs ( $\beta_{PQ \rightarrow CW(+)} = 0.08, p = 0.37$ ) at all, which makes *H6* and *H7* unsupported. As for perceived value, perceived benefit influenced students' willingness positively ( $\beta_{PB \rightarrow CW(+)} = 0.49, p < 0.001$ ), while perceived cost in reverse ( $\beta_{PC \rightarrow CW(-)} = -0.12, p < 0.05$ ), which respectively supported *H2* and *H3*. The influence of perceived benefit turned out to be much greater than perceived cost. Social influence had a positive effect on students' willingness ( $\beta_{SI \rightarrow CW(+)} = -0.12, p < 0.01$ ), perceived benefits ( $\beta_{SI \rightarrow PB(+)} = 0.48, p < 0.001$ ), and perceived costs ( $\beta_{SI \rightarrow PC(+)} = 0.3, p < 0.01$ ), which supports *H8, H9, and H10*.

**Table 5** Results of Structural Model Coefficient Paths

Hypothesis	$\beta$	SE	<i>p</i>	Results
<b>Perceived quality</b>				
PQ → CW (+)	0.08	0.12	0.37	Not supported
PQ → PB (+)	0.43	0.09	***	Supported
PQ → PC (-)	0.15	0.14	0.19	Not supported
<b>Perceived value</b>				
PB → CW (+)	0.49	0.12	***	Supported
PC → CW (-)	-0.12	0.05	*	Supported
<b>Social influence</b>				
SI → CW (+)	0.30	0.13	**	Supported
SI → PB (+)	0.48	0.09	***	Supported
SI → PC (+)	0.30	0.13	**	Supported

Note.  $\beta$  = standardized estimate; SE = standard error; \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$  (same as follows).

The testing results of coefficient paths starting from social influence and the two perceived value factors create a prerequisite for testing the mediating effect of perceived value between social influence and students' willingness. As in Table 6, the results of specific indirect effect demonstrate that perceive benefit and perceived cost have mediation effect ( $SIE_{SI \rightarrow PB \rightarrow CW} = 0.27, p < 0.01$ ;  $SIE_{SI \rightarrow PC \rightarrow CW} = -0.04, p < 0.05$ ), which respectively supports *H11* and *H12*.

**Table 6** Results of Mediation Effect

Path	Point estimate	Product of coef.		Bootstrapping (N = 1,000)					
		SE	Z	Bias-corrected 95% CI			Percentile 95% CI		
				Lower	Upper	Sig.	Lower	Upper	Sig.
<b>Total effect</b>									
SI → CW	0.578	0.173	0.341	0.232	0.909	0.003**	0.252	0.935	0.002**
<b>Direct effect (DE)</b>									
SI → CW	0.349	0.213	1.638	-0.04	0.751	0.109	-0.031	0.797	0.085
<b>Total indirect effect (TIE)</b>									
SI → CW	0.23	0.117	1.966	0.056	0.546	0.011*	0.028	0.49	0.025*
<b>Specific indirect effect (SIE)</b>									
SI → PB → CW	0.27	0.115	2.348	0.095	0.58	0.003**	0.079	0.536	0.006**
SI → PC → CW	-0.041	0.03	-1.367	-0.14	-0.005	0.019*	-0.112	-0.001	0.04*

As shown in Table 7, the chi-square difference between male ( $N = 148$ ) and female ( $N = 126$ ) groups in SI → CW path is significant ( $\Delta\chi^2/\Delta df = 4.25, p < 0.05$ ). This implies that the impact of social influence on students' continuous willingness to use VSLs varied by gender of students. It turns out that female students are more likely to be influenced by their societal surroundings. At the same time, no moderation effect is found for other three variables (i.e. grade, major, and compulsory degree).

As shown in Figure 2, 61.6% variance of CW is explained.

**Table 7** Results of Moderation Effect of Gender

Equal path	Standardized path coefficient		$\Delta\chi^2$ ( $\Delta df = 1$ )	CFI Uncons/ Cons	RMSEA Uncons/ Cons
	Male ( $N = 148$ )	Female ( $N = 126$ )			
PQ → CW	0.096 <sup>ns</sup>	0.005 <sup>ns</sup>	0.213 <sup>ns</sup>	0.93/0.93	0.065/0.065
SI → CW	0.12 <sup>ns</sup>	0.531 <sup>**</sup>	4.256 <sup>*</sup>	0.93/0.93	0.065/0.065
PB → CW	0.639 <sup>***</sup>	0.318 <sup>*</sup>	1.664 <sup>ns</sup>	0.93/0.93	0.065/0.065
PC → CW	-0.049 <sup>ns</sup>	-0.199 <sup>*</sup>	1.585 <sup>ns</sup>	0.93/0.93	0.065/0.065

Note. ns = not significant (same as follows).

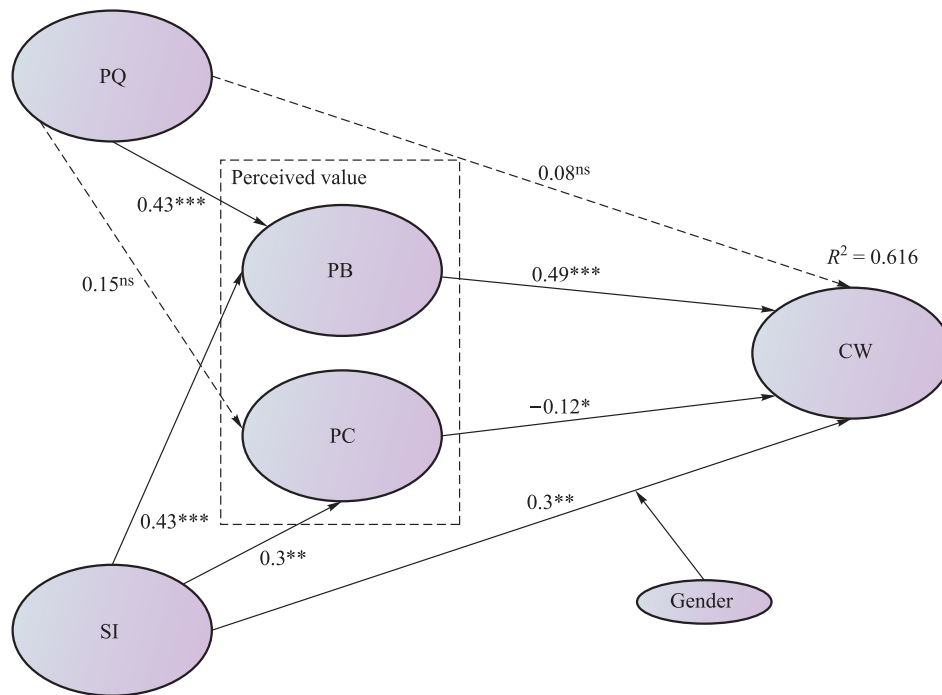


Figure 2 Modified Research Model for This Study

## 6 Discussion and Conclusion

### 6.1 | Discussion

The primary objective of this study is to identify effective predictors of students' consistent willingness to learn with VSLs and contribute to the theoretical research on the diffusion and acceptance of new e-learning technologies. Drawing on a comprehensive literature review, this study examined the impact of perceived quality, perceived value, and social influence on students' continuous willingness to learn with VSLs.

The results of the SEM analysis reveal that perceived value emerged as the most influential factor. This can largely be attributed to students' perception of the learning benefits offered by VSLs, aligning with previous studies that have highlighted the impact of utility and hedonic motives on students' acceptance of e-learning (Gunasinghe et al., 2020). In comparison, the perceived cost only has a slight negative impact on students' willingness to learn with VSLs. In addition, VSLs are generally provided to students free of charge by schools, this can be attributed to the fact that learning tasks on VSLs are not time-consuming till now as well. As shown in the questionnaire results, which show that most students spent less than 2 hours per week using VSLs. Consequently, the perceived opportunity costs associated with VSLs usage are minimized, thereby reducing students' perception of hindrances. This finding is consistent with previous Technology Acceptance Model (TAM)-

based studies, which suggest that perceived usefulness is a stronger predictor than perceived ease of use in the context of e-learning technology (Al-Azawei et al., 2017; Al-hawari & Mouakket, 2010; Mohammadi, 2015; Salloum et al., 2019), as well as Unified Theory of Acceptance and Use of Technology UTAUT-based studies, which indicate that perceived efficiency is more influential than perceived effort (Tarhini et al., 2017). Therefore, it is crucial to ensure that students perceive and actually experience learning benefits from using VSLs.

Social influence emerged as the second most influential factor on students' willingness, supporting Rogers's notion that the social system plays a critical role in promoting innovation. This finding is also consistent with previous studies that have demonstrated the impact of social factors such as subjective norms (Chu & Chen, 2016; Park, 2009) and social media (Alghizzawi et al., 2019; Salloum et al., 2021) on students' acceptance of e-learning. The mediation effect test indicates that social influence operates through perceived benefits. This suggests, to some extent, that the role of lecturers, fellow students, and the media is no more significant than students themselves confirming and recognizing the benefits they can derive from learning with VSLs. Consistent with the conclusions of numerous studies, female students are more likely to be influenced by social factors in their continued use of VSLs, which can be attributed to compliant personality traits shaped by social gender roles (Goswami & Dutta, 2015; Venkatesh et al., 2003; Venkatesh & Morris, 2000).

Interestingly, perceived quality does not directly

affect students' willingness. This finding aligns with the research by Islam (2012), which highlights the controversy surrounding the effectiveness of perceived quality as a predictor of users' willingness to adopt an information system. In the field of information systems, some scholars argue that perceived quality directly influences users' willingness (DeLone & McLean, 2003), while others suggest that the effect is indirect (Davis, 1989; Seddon, 1997). Wixom and Todd (2005) also view object-based beliefs, such as perceived system quality, as inferior predictors of behavioral intention. The findings of this study support the latter perspective, as perceived quality was found to have an indirect influence on perceived benefits. This finding supports Woodruff's assertion that, in certain cases, perceived value outweighs perceived quality in attracting more users.

This study aimed to find effective predictors of students' willingness to learn with VSLs consistently and contribute theoretically to research on diffusion and acceptance of new e-learning technologies. Based on the literature review, the study respectively examined the impact of perceived quality, perceived value and social influence on students' continuous willingness to learn with VSLs.

The SEM analysis revealed that perceived value was the most influential factor. This is mainly due to students' perception of VSLs learning benefits and is consistent with previous studies on the impacts of utility and hedonic motives on students' acceptance of e-learning (Gunasinghe et al., 2020). Comparatively, perceived cost had only a slight negative impact on students' willingness to learn with VSLs. This could be attributed to the fact that learning tasks on VSLs did not take long, as the questionnaire results revealed that most respondent students used VSLs less than 2 hours per week. This may have prevented excessive VSLs usage from delaying other valuable learning tasks too much which in turn reduced students' perception of opportunity costs. Overall, this result of comparison is consistent with previous TAM-based studies indicating that perceived usefulness could be a stronger predictor than perceived ease of use in the e-learning technology (Al-Azawei et al., 2017; Al-hawari & Mouakket, 2010; Mohammadi, 2015; Salloum et al., 2019) and UTAUT-based studies indicating perceived efficiency better than perceived effort (Tarhini et al., 2017). Therefore, it is especially imperative to make students feel that they can and actually gain learning benefits from VSLs.

Social influence turned out to be the second influential factor on students' willingness, which supported Rogers's notion that social system played a critical role in promoting an innovation. It is also consistent with previous studies proving the impacts of social factors like subjective norms (Chu & Chen, 2016; Park 2009) and social media (Alghizzawi et al., 2019; Salloum et al., 2021) on students' acceptance of e-learning. The mediation

effect test indicated that social influence must be realized through perceived benefit. This to some extent suggests that the role of the lecturer, fellow students and the media is no more significant than the students themselves confirming and recognizing that they can benefit from learning with VSLs. Consistent with the conclusions of many studies, women are more likely to be influenced by social factors to the continued use of VSLs, which is related to more compliant personality traits constructed by social gender roles (Goswami & Dutta, 2015; Venkatesh et al., 2003; Venkatesh & Morris, 2000).

Perceived quality failed to affect students' willingness directly. This is consistent with the findings of Islam (2012). He mentioned the controversy about whether perceived quality could be an effective predictor of users' willingness to adopt an information system. In the area of information systems, some scholars argue that perceived quality directly influenced user willingness (DeLone & McLean, 2003), while others argued that the effect was indirect (Davis, 1989; Seddon, 1997). Wixom and Todd (2005) also view object-based beliefs like perceived system quality as inferior predictors of behavioral intention. The findings of this study clearly supports the latter, since perceived quality is found influential on perceived benefit. It also supports Woodruff's assertion (Woodruff, 1997) that in some cases, perceived value is more important than perceived quality for winning more users.

## 6.2 | Conclusion

According to the above findings, it is imperative to help students feel and actually gain learning benefits by using VSLs consistently, as perceived benefit is the most influential factor. In the context of this study, these benefits include higher grades, enhanced students' operational and problem-solving skills, and increased learning interests. Therefore, the developers and instructors must consider how to enhance these benefits as well as tap into additional benefits. These can be achieved by simultaneously enhancing the quality of VSLs and relevant social communication. On the one hand, developers need to consistently improve the technical performance of VSLs, but also the design of virtual simulation and instruction. It is important for them to focus on the needs and goals of students and to be student-centered.

On the other hand, social communication related to VSLs needs to be enhanced, especially for female students. To begin with, teachers are supposed to show more supports for students to learn with VSLs. Besides asking students to use VSLs directly, other measures include: increasing the portion of learning outcomes of learning with VSLs in the final assessment, discussing VSLs' benefits more frequently, guiding students to discover these benefits through reflective assessment, encouraging students to exchange learning experiences

regarding VSLs. Schools and VSLs suppliers could increase the positive media exposure of VSLs to inform students of the existence and benefits of VSLs. In the context of this study, these societal approaches have the potential to compensate for any deficiencies in students' perception of the quality of VSLs.

Based on the aforementioned findings, it is crucial to ensure that students perceive and actually experience the benefits of using VSLs consistently, as perceived benefit is the most influential factor. In the scope of this study, these benefits encompass improved academic performance, enhanced operational and problem-solving skills, as well as increased interest in learning. Consequently, developers and instructors must deliberate on methods to augment these benefits while also exploring additional advantages. This can be accomplished by concurrently enhancing the quality of VSLs and fostering effective social communication.

On one hand, developers should strive for continuous improvement in the technical performance of VSLs, as well as the design of virtual simulations and instructional materials. It is imperative for them to prioritize the needs and objectives of students, adopting a student-centered approach.

On the other hand, social communication pertaining to VSLs needs to be strengthened, particularly for female students. Firstly, teachers should offer greater supports for students utilizing VSLs for learning. In addition to direct encouragement, other measures may include: increasing the weight of learning outcomes associated with VSLs in the final assessments, engaging in frequent discussions about the benefits of VSLs, guiding students to recognize these benefits through reflective assessments, and encouraging the exchange of learning experiences related to VSLs. Schools and VSLs suppliers could also amplify positive media exposure to raise awareness among students regarding the existence and advantages of VSLs. These societal approaches, within the context of this study, have the potential to compensate for any deficiencies in students' perception of the quality of VSLs.

## 7 Limitation and Future Research

This study should address the following limitations in order to provide more comprehensive analyses in the future. Firstly, it would be better to increase the sample size in order to verify whether the findings of this study are applicable to higher education institutions in China. Secondly, both perceived value and quality are intricate concepts, and this study just briefly examine their composition to facilitate quantitative research. Therefore, future research should delve deeper into these core concepts, drawing from the actual construction and application experience of VSLs. Thirdly, it is crucial to test

the variance of the proposed theoretical model's predictive performance in different cultural and educational contexts. For instance, it is worth exploring whether the model's effectiveness varies among different student types, countries, and geographic regions. These aspects should be taken into consideration in future research endeavors.

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## References

- Al-Azawei, A., Parslow, P., & Lundqvist, K. (2017). Investigating the effect of learning styles in a blended e-learning system: An extension of the technology acceptance model (TAM). *Australasian Journal of Educational Technology*, (2), 1–23.
- Al-Fraihat, D., Joy, M., & Sinclair, J. (2020). Evaluating e-learning systems success: An empirical study. *Computers in Human Behavior*, (C), 67–86.
- Alhizzawi, M., Habes, M., Salloum, S. A., Ghani, M. A., Mhamdi, C., & Shaalan, K. (2019). The effect of social media usage on students' e-learning acceptance in higher education: A case study from the United Arab Emirates. *International Journal of Information Technology and Language Studies*, (3), 13–26.
- Al-hawari, M. A., & Mouakket, S. (2010). The influence of technology acceptance model (TAM) factors on students' e-satisfaction and e-retention within the context of UAE e-learning. *Education, Business and Society: Contemporary Middle Eastern Issues*, (4), 299–314.
- Araiza-Alba, P., Keane, T., Chen, W. S., & Kaufman, J. (2021). Immersive virtual reality as a tool to learn problem-solving skills. *Computers & Education*, 164, 104121.
- Ball, C., Huang, K. T., Rikard, R. V., & Cotten, S. R. (2019). The emotional costs of computers: An expectancy-value theory analysis of predominantly low-socioeconomic status minority students' STEM attitudes. *Information, Communication & Society*, (1), 105–128.
- Bandura, A. (1986). *Social foundations of thought and action*. Prentice Hall.
- Becker, M. C., Salvatore, P., & Zirpoli, F. (2005). The impact of virtual simulation tools on problem-solving and new product development organization. *Research Policy*, (9), 1305–1321.
- Byrne, B. M. (2001). Structural equation modeling with AMOS, EQS, and LISREL: Comparative approaches to testing for the factorial validity of a measuring instrument. *International Journal of Testing*, (1), 55–86.
- Cambridge University Hospitals NHS Foundation Trust. (2022, January 6). *Hologram patients to help train future doctors and nurses*. Available online at NHS website.
- Chin, W. W. (1998). Commentary: Issues and opinions on structural equation modeling. *MIS Quarterly*, (1), vii–xvi.

- Chu, T. H., & Chen, Y. Y. (2016). With good we become good: Understanding e-learning adoption by theory of planned behavior and group influences. *Computers & Education*, 92, 37–52.
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 319–340.
- De Ruyter, K., Wetzels, M., & Kleijnen, M. (2001). Customer adoption of e-service: An experimental study. *International Journal of Service Industry Management*, (2), 184–207.
- DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: A ten-year update. *Journal of Management Information Systems*, (4), 9–30.
- Dubovi, I., Levy, S. T., & Dagan, E. (2017). Now I know how! The learning process of medication administration among nursing students with non-immersive desktop virtual reality simulation. *Computers & Education*, 113, 16–27.
- Felsenstein, J. (1985). Confidence limits on phylogenies: An approach using the bootstrap. *Evolution*, (4), 783–791.
- Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, (1), 39–50.
- Fortune Business Insights. (2023, September 12). *Virtual reality market size to surpass USD165.91 billion by 2030, exhibiting a CAGR of 31.0%*.
- Gavarkovs, A., Kusrkar, R. A., Kulasegaram, K., Crukley, J., Miller, E., Anderson, M., & Brydges, R. (2022). Motivational design for web-based instruction in health professions education: Protocol for a systematic review and directed content analysis. *JMIR Research Protocols*, (11), e42681.
- Goswami, A., Dutta, S. (2015). Gender differences in technology usage—A literature review. *Open Journal of Business and Management*, (1), 51–59.
- Gunasinghe, A., Hamid, J. A., Khatibi, A., & Azam, S. F. (2020). The adequacy of UTAUT-3 in interpreting academician's adoption to e-learning in higher education environments. *Interactive Technology and Smart Education*, (1), 86–106.
- Gunawan, G., Harjono, A., Sahidu, H., & Herayanti, L. (2017). Virtual laboratory to improve students' problem-solving skills on electricity concepts. *Journal Pendidikan IPA Indonesia*, (2), 257–264.
- Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis*. Cengage.
- Harvard University. (2020, January 22). *Free "LabXchange" science education accelerator launched by amgen foundation and Harvard's faculty of arts and sciences*.
- Huang, W. D., Johnson, T. E., & Han, S. H. C. (2013). Impact of online instructional game features on college students' perceived motivational support and cognitive investment: A structural equation modeling study. *The Internet and Higher Education*, 17, 58–68.
- Hulland, J. (1999). Use of partial least squares (PLS) in strategic management research: A review of four recent studies. *Strategic Management Journal*, (2), 195–204.
- iLab-X. (2023, December 20). *Data Statistics*. Available online at iLab-X website.
- Islam, A. K. M. (2012). The role of perceived system quality as educators' motivation to continue e-learning system use. *AIS Transactions on Human-Computer Interaction*, (1), 25–43.
- Jiang, S., Jotikasthira, N., & Pu, R. (2022). Toward sustainable consumption behavior in online education industry: The role of consumer value and social identity. *Frontiers in Psychology*, 13.
- Jou, M., & Wang, J. (2013). Investigation of effects of virtual reality environments on learning performance of technical skills. *Computers in Human Behavior*, (2), 433–438.
- Kettinger, W. J., & Smith, J. (2009). Understanding the consequences of information systems service quality on IS service reuse. *Information & Management*, (6), 335–341.
- Kline, R. B. (2023). *Principles and practice of structural equation modeling*. The Guilford Press.
- Kyriazos, T. A. (2018). Applied psychometrics: Sample size and sample power considerations in factor analysis (EFA, CFA) and SEM in general. *Psychology*, (8), 2207.
- Lew, S. L., Lau, S. H., & Leow, M. C. (2019). Usability factors predicting continuance of intention to use cloud e-learning application. *Heliyon*, (6), e01788.
- Li, Y., Duan, Y., Fu, Z., & Alford, P. (2012). An empirical study on behavioural intention to reuse e-learning systems in rural China. *British Journal of Educational Technology*, (6), 933–948.
- Li, Y., & Shang, H. (2020). Service quality, perceived value, and citizens' continuous-use intention regarding e-government: Empirical evidence from China. *Information & Management*, (3), 103197.
- Liaw, S. S., & Huang, H. M. (2013). Perceived satisfaction, perceived usefulness and interactive learning environments as predictors to self-regulation in e-learning environments. *Computers & Education*, (1), 14–24.
- Lin, W. S., & Wang, C. H. (2012). Antecedences to continued intentions of adopting e-learning system in blended learning instruction: A contingency framework based on models of information system success and task-technology fit. *Computers & Education*, (1), 88–99.
- Lovelock, C. H. (2000). *Service marketing* (4th ed.). Prentice Hall International.
- Mohammadi, H. (2015). Investigating users' perspectives on e-learning: An integration of TAM and IS success model. *Computers in Human Behavior*, 45, 359–374.
- Mondi, M., Woods, P., & Rafi, A. (2007). Students' "uses and gratification expectancy" conceptual framework in relation to e-learning resources. *Asia Pacific Education Review*, (3), 435–449.
- Netemeyer, R. G., Bearden, W. O., & Sharma, S. (2003). *Scaling procedures: Issues and applications*. Sage Publications.
- Nguyen, T. D., Nguyen, D. T., & Cao, T. H. (2014). Acceptance and use of information system: E-learning based on cloud computing in Vietnam. In: *Proceedings of Information and Communication Technology-EurAsia Conference*, 139–149.
- OMS. (2023). *Helping you transform healthcare training*. Available online at OMS website.
- Ozkan, S., & Koseler, R. (2009). Multi-dimensional students' evaluation of e-learning systems in the higher education context: An empirical investigation. *Computers & Education*, (4), 1285–1296.
- Park, S. Y. (2009). An analysis of the technology acceptance model in understanding university students' behavioral intention to use e-learning. *Journal of Educational Technology & Society*, (3), 150–162.
- Pereira, F. A., Ramos, A. S. M., Gouvêa, M. A., & da Costa, M. F. (2015).

- Satisfaction and continuous use intention of e-learning service in Brazilian public organizations. *Computers in Human Behavior*, 46, 139–148.
- Pham, L., Limbu, Y. B., Bui, T. K., Nguyen, H. T., & Pham, H. T. (2019). Does e-learning service quality influence e-learning student satisfaction and loyalty? Evidence from Vietnam. *International Journal of Educational Technology in Higher Education*, (1), 1–26.
- Pham, L., Williamson, S., & Berry, R. (2018). Student perceptions of e-learning service quality, e-satisfaction, and e-loyalty. *International Journal of Enterprise Information Systems (IJEIS)*, (3), 19–40.
- Rajeh, M. T., Abduljabbar, F. H., Alqahtani, S. M., Waly, F. J., Alnaami, I., Aljurayyan, A., & Alzaman, N. (2021). Students' satisfaction and continued intention toward e-learning: A theory-based study. *Medical Education Online*, (1), 1961348.
- Rogers, E. M., Singhal, A., & Quinlan, M. M. (2014). *An integrated approach to communication theory and research*. Routledge.
- Rogers, L. (2011). Developing simulations in multi-user virtual environments to enhance healthcare education. *British Journal of Educational Technology*, (4), 608–615.
- Saini, S., Preble, S., Popović, M., Cardenas, J., Kost, A., Verlage, E., Holand, G. A., & Kimerling, L. C. (2019). Integrated photonics and application-specific design on a massive open online course platform. *Education and Training in Optics and Photonics: ETOP 2019*, 111430Y.
- Salloum, S. A., Alhamad, A. Q. M., Al-Emran, M., Monem, A. A., & Shaalan, K. (2019). Exploring students' acceptance of e-learning through the development of a comprehensive technology acceptance model. *IEEE Access*, 7, 128445–128462.
- Salloum, S. A., Al-Emran, M., Habes, M., Alghizzawi, M., Ghani, M. A., & Shaalan, K. (2021). What impacts the acceptance of e-learning through social media? An empirical study. In M. Al-Emran, & K. Shaalan (Eds.), *Recent advances in technology acceptance models and theories* (pp. 419–431). Springer.
- Santos, J. (2003). E-service quality: A model of virtual service quality dimensions. *Managing Service Quality: An International Journal*, (3), 233–246.
- Seddon, P. B. (1997). A respecification and extension of the DeLone and McLean model of IS success. *Information Systems Research*, (3), 240–253.
- Sheth, J. N., Newman, B. I., & Gross, B. L. (1991). Why we buy what we buy: A theory of consumption values. *Journal of Business Research*, (2), 159–170.
- Shi, J., & Liang, H. (2012). Explore the effective use of multimedia technology in college physics teaching. *Energy Procedia*, 17, 1897–1900.
- Smith, P. C., & Hamilton, B. K. (2015). The effects of virtual reality simulation as a teaching strategy for skills preparation in nursing students. *Clinical Simulation in Nursing*, (1), 52–58.
- Strang, D., & Soule, S. A. (1998). Diffusion in organizations and social movements: From hybrid corn to poison pills. *Annual Review of Sociology*, (1), 265–290.
- Su, C. H. (2016). The effects of students' motivation, cognitive load and learning anxiety in gamification software engineering education: A structural equation modeling study. *Multimedia Tools and Applications*, (16), 10013–10036.
- Sweeney, J. C., & Soutar, G. N. (2001). Consumer perceived value: The development of a multiple-item scale. *Journal of Retailing*, (2), 203–220.
- Tarhini, A., Masa'deh, R. E., Al-Busaidi, K. A., Mohammed, A. B., & Maqableh, M. (2017). Factors influencing students' adoption of e-learning: A structural equation modeling approach. *Journal of International Education in Business*, (2), 164–182.
- The Ministry of Education of the People's Republic of China. (2013, August 13). *Notice on the construction of national virtual simulation experimental teaching center*. Available online at MoE of the People's Republic of China.
- Venkatesh, V., Morris, M. G. (2000). Why don't men ever stop to ask for directions? Gender, social influence, and their role in technology acceptance and usage behavior. *Institutions & Transition Economics: Microeconomic Issues eJournal*, 115–139.
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *Institutions & Transition Economics: Microeconomic Issues eJournal*, 27(3), 425–478.
- Verkuyl, M., Romaniuk, D., & Mastrilli, P. (2018). Virtual gaming simulation of a mental health assessment: A usability study. *Nurse Education in Practice*, 31, 83–87.
- Wixom, B. H., & Todd, P. A. (2005). A theoretical integration of user satisfaction and technology acceptance. *Information Systems Research*, (1), 85–102.
- Wong, W. T., & Huang, N. N. T. (2011). The effects of e-learning system service quality and users' acceptance on organizational learning. *International Journal of Business and Information*, (2), 205–225.
- Woodruff, R. B. (1997). Customer value: The next source of competitive advantage. *Journal of the Academy of Marketing Science*, (2), 139–153.
- Wu, M., Kang, L., Li, X., & Zhao, J. L. (2016). Participation in open knowledge-sharing community: Expectancy value perspective. In: *Proceedings of International Conference on HCI in Business, Government, and Organizations*, 153–162.
- Yen, C. H., & Lu, H. P. (2008). Effects of e-service quality on loyalty intention: An empirical study in online auction. *Managing Service Quality: An International Journal*, (2), 127–146.
- Yuliati, L., Riantoni, C., & Mufti, N. (2018). Problem solving skills on direct current electricity through inquiry-based learning with PhET simulations. *International Journal of Instruction*, (4), 123–138.
- Zeithaml, V. A. (1988). Consumer perceptions of price, quality, and value: A means-end model and synthesis of evidence. *Journal of Marketing*, (3), 2–22.