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Research Article

Factors Affecting Learners' Adoption of an Educational Metaverse Platform: An Empirical Study Based on an Extended UTAUT Model

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This study examined the factors affecting learners' adoption of an educational metaverse platform using an extended UTAUT (unified theory of acceptance and use of technology) model and incorporating perceived risk. Data were derived from a survey of 495 respondents from China and analyzed using structural equation modeling. The results revealed that (i) performance expectancy, effort expectancy, social influence, and facilitating conditions had significantly positive effects on learners' satisfaction with the Eduverse; (ii) learners' satisfaction had a positive effect on their continued usage intention; (iii) learners' intention to use the Eduverse was reduced after they perceived risks. Our study provided empirical evidence of the validity of the UTAUT model in explaining learners' adoption of the Eduverse. Our findings have significant practical implications for enterprises, educational institutions, and governments.

1. Introduction

The COVID-19 pandemic has compelled many educational institutions to switch abruptly from traditional attendance-based education to online distance education to avoid face-to-face interactions [1]. Depending on the mode of delivery, online distance education can be either asynchronous or synchronous [2]. Both types of online learning occur in two-dimensional (2D) web-based virtual environments, in which digital windows only have length and width, but no thickness or depth [3]. Asynchronous online learning platforms (such as Moodle and Blackboard) afford flexible communication between learners and educators at any time and from anywhere [4], thus allowing learners to engage deeply with complex study materials [5]. Synchronous online learning platforms (such as Zoom, Adobe Connect, and VooV Meeting) enable instantaneous interaction between learners and educators, thus stimulating learner engagement in the class [6]. The flexibility, accessibility, and affordability of 2D e-learning platforms enable them to serve as an alternative for offline modes of pedagogical delivery; they have even been described as a "panacea" for problem-facing education during the COVID-19 crisis [1].

However, applying 2D e-learning platforms in educational settings also has well-documented limitations including inattention, inactivity, emotional isolation, poor self-perception, and so on. In particular, learners are exposed to more distractions when taking online courses than during teacher-supervised classes, mainly due to their unavoidable multitasking behavior. For example, online students have a tendency to use their electronic devices to perform other tasks during class, resulting in low course completion rates [7] and poor academic performance [8]. In addition, online learners may not be highly self-motivated to interact, as 2D learning tools confine them to passive participation [6]. Both learners and educators may feel emotionally isolated from the learning environment and have great difficulty expressing their real-time emotions (except for sending emojis) [2]. Moreover, self-perception is low in users of 2D learning platforms since they may see themselves represented as disembodied entities through a live webcam or an image [3]. These problems associated with 2D online learning can be alleviated by three-dimensional (3D) immersive spatial environments powered by the metaverse.

The metaverse is a 3D-based virtual environment where users can interact with virtual space, digital objects, and people via configurable digital bodies called avatars [1–4]. It utilizes multisensory immersive technology referred to as extended reality (XR), and includes virtual reality (VR), augmented reality (AR), and mixed reality (MR) [3]. These technologies enable multimodal metaverse interactions with virtual world and digital avatars, thus alleviating the aforementioned problems of 2D e-learning platforms. In particular, 3D systems such as XR can provide superior auditory and spatial experiences compared with 2D systems [9], thus producing a higher level of immersion through the spatial distribution of sound, which acts as a powerful medium for user attention attraction [3]. XR systems not only allow passive sensory inputs but also encourage active interactions with virtual objects through various motion controllers and wearable devices [10]. This capability renders users active rather than passive learners in any educational experience [3], thus fostering a learning culture of inclusion and improving users' self-perception [11].

The metaverse can be applied to various fields such as politics, economics, social sciences, cultural studies, and education [12–14]. The application of this technology in educational settings has become a reality in many countries and has proven improved learners' online learning performance [15–17]. However, what factors affect the acceptance and adoption of the educational metaverse (hereinafter referred to as the "Eduverse") as seen from learners' perspectives is still an unanswered question.

To explain users' technology acceptance behavior, prior researchers developed several theories and models, most of which were reviewed, compared, and integrated by Venkatesh et al. into a more complete model called the unified theory of acceptance and use of technology (UTAUT) [16, 18]. The UTAUT model is considered as one of the best developed and powerful technology acceptance theories [19, 20]. The objective of this study, therefore, is to explore factors that influence learners' adoption of the Eduverse based on an extended UTAUT model. To this end, we conducted a survey using data from a sample of 495 Chinese respondents. We employed structural equation modeling (SEM) to investigate the structural relationship between each of the items on the UTAUT and adoption of the Eduverse. We also considered the role of perceived risk in users' intention to continue using this metaverse platform.

The remainder of this article is structured as follows. Section 2 reviews the prior literature related to the Eduverse and the UTAUT. Section 3 presents the application of the UTAUT theory to the Eduverse and states the research hypotheses. Section 4 describes the development of our measures, the survey procedure, and the data collection process. Section 5 presents the empirical results. Section 6 provides the conclusions and implications of our research, finishing with directions for future studies.

2. Literature Review

2.1. The Eduverse: Educational Applications of the Metaverse. Although education is essential for economic and social development, its fundamental structure and practices remain largely unchanged despite numerous innovations in digital technologies [21] (pp. 149). However, the metaverse has the potential to bring about a paradigm shift in online education. Several attributes that set it apart from other 2D e-learning tools include interactivity, corporeity, and persistence. In the Eduverse, users interact with each other in a virtual online environment without limitations of space and time, which makes learning activities more collaborative, although autonomous learning is also possible. In the Eduverse, the construction of online identity is achieved by avatars, the virtual entities that represent users. Although it is a virtual world, it is subject to the laws of physics and has limited resources; this is the corporeity element. In the Eduverse, the virtual world continues to exist and function even when users log out of the metaverse platform, and the saved information can be retrieved when they reconnect; this is the persistence element [22, 23].

The Eduverse can be helpful in problem-based learning (PBL) and learner-centered teaching (LCT). The PBL approach is effective in achieving learning objectives [24]. This approach is especially useful in the Eduverse where learners, represented by avatars, must provide solutions to various problems. Educators pose challenging questions that learners, as avatars, must examine and answer in collaboration with other students, which can strengthen their teamwork skills and enhance their interest in learning [25]. According to constructivist theory, the subject of learning should be the learners themselves rather than the knowledge being taught [26]. Research has shown that utilizing the Eduverse can pave the way for LCT by encouraging both collaborative and autonomous learning [22, 27].

The use of the Eduverse for PBL and LCT can provide educational benefits in various educational settings and subjects such as mathematics [28], aircraft maintenance simulation [29], medical teaching [30], and science, technology, engineering, and mathematics (STEM) education [31]. However, the use of the Eduverse is accompanied by potential risks, which include (i) damage to physical health, (ii) damage to mental health, (iii) moral concerns, and (iv) privacy impingement. On the physical level, VR-based technologies are associated with health concerns like dizziness, sickness, and nausea [32]. AR-based technologies in the metaverse can distract users' attention from the real world and may lead to harmful accidents. On the psychological level, information overload, weak social connections, and possible traumatic experiences in the VR or AR environment may harm users' mental health [33]. On the moral level, since users occupy virtual space when using the Eduverse, their sense of right and wrong may be reduced when they violate cultural norms or even commit crimes [34]. In terms of privacy, personal information like biometric data may be disseminated and used for commercial purposes. Context-aware AR may capture information about the surrounding environment, causing a violation of volumetric privacy. In addition, geolocation tracking may reveal intimate personal information and lead to an invasion of physical privacy [35]. Figure 1 illustrates the technologies, features, applications, and potential risks of the Eduverse.

2.2. VR/AR/MR in Education. The development of the metaverse is highly dependent on the advances in its underlying technologies such as VR, AR, and MR [3]. To create a fully immersive experience, the metaverse needs technologies that can ensure an entirely simulated experience in virtual environments, which can be delivered by the VR, AR, and MR technologies [3, 12]. Although VR and AR are different in terms of the extent of immersion [36, 37], they share three key features: immersion, presence, and engagement [38]. Immersion, a quantifiable description of a system's technical capabilities, means the extent to which the VR/AR/MR technology can deliver an environment where a user can have a sense of reality [39, 40]. Presence refers to the user's sense of being in the simulated reality, and it is more about how the users perceive reality [41–43]. Engagement, divided into behavioral, emotional, and cognitive engagement [44], refers to the combination of increased interest, concentration, and enjoyment that learners experience [45, 46].

In view of the above characteristics of VR/AR/MR, the application of them in education has been found to have positive effects on improving learning outcomes. First, the immersion feature of VR/AR/MR can be helpful in improving learning efficiency since it allows learners to both mentally and emotionally engage in the simulated real-life situations [47, 48]. In addition, since VR/AR/MR learning scenarios enable on-demand repetition, the immersive experiences can improve students' absorption and understanding of knowledge [46, 49].

Second, the presence feature of VR/AR can enhance experiential learning by involving a broad spectrum of sensory-motor interactions, which would otherwise be inaccessible in real life because of high costs or risks [50]. When comparing the level of presence that VR and MR can produce in the learning process, Allcoat et al. found that the former produced a higher sense of presence than the latter, suggesting that VR led to higher levels of immersion [43].

Third, the engagement feature of VR/AR/MR, referring to "the extent to which a learner applies a level of attention and curiosity to a situation to achieve a desirable result" [46], has been found to increase happiness, motivation, and long-term dedication [49]. In a study conducted by Marks and Thomas [51], they found that 71.5% of subjects reported enhanced learning performance when they used VR/AR for the first time. Therefore, they suggested that higher education institutions should invest in VR/AR technologies [51]. Lindgren et al. found that studying physics in an MR educational environment led to higher levels of engagement, more positive learning attitudes, and higher learning gains than traditional desktop-based computer simulations [48]. Tang et al. found that MR significantly improved students' abilities in geometric analysis and creativity in learning design subjects [52]. Similarly, Allcoat et al. found that both VR and MR could contribute to higher levels of engagement compared to traditional learning methods, and the former produced higher levels of positive emotions than the latter [43].

However, VR/AR/MR on its own does not ensure positive learning outcomes [53, 54], and factors that affect the effectiveness of VR/AR/MR in education have been well documented in the literature. Based on the presence theory [55] and regulatory focus theory [56], Sun et al. [57] found that promotion focus (i.e., the tendency focuses on the positive presence) positively affects students' satisfaction, perceived efficiency, and overall usability perception toward VR-based learning, whereas involvement (i.e., a psychological state that focuses an individual's attention on a coherent set of activities) and promotion focus positively affect students' perceived effectiveness of VR. Portman et al. [58] and Potkonjak et al. [59] found that students' multisensory experiences, the quality of teaching content, and the adequacy of realistic dynamic interactions can affect the effectiveness of VR/AR. In addition, Kim et al. [60] found that sensory immersion, VR technology recognition, realism, learning necessity and satisfaction, and continuous usage intention are positively correlated with the learning outcomes of VR. Students' personality traits, such as conscientiousness, extraversion, and openness, are also proved to be positively correlated with the learning effects of VR [60]. Asad et al. reported that the user-friendliness of the VR technology ensures its implementation, thus enhancing experiential learning [49]. Tegoan et al. mentioned that although MR could enhance language learning, its effectiveness could be affected by privacy concerns, expensive costs, etc. [54].

Other studies employed theories related to technology acceptance to explore factors affecting learners in the educational environment to which VR, AR, and MR technologies are applied. Based on the technology acceptance model (TAM), Singh and Lee [61] found that the playfulness and usefulness of a VR system are positively correlated with students' attitude and usage intention toward VR. Similarly, Abd Majid and Mohd Shamsudin [62] also found that the perceived usefulness of VR has a significant influence on students' attitude and intention to use VR, whereas perceived ease of use is not significantly associated with their attitude toward VR. Shen et al. [36] found that perceived usefulness, price value, and playfulness are determining factors for students' adoption and use of VR/AR. Rasimah et al. noticed that researchers usually merge other constructs that are deemed appropriate for technology acceptance with the basic TAM model [40]. Therefore, their study synthesized 27 different factors into four types of constructs that affect the acceptance of AR/MR after they undertook a systematic literature review of 26 previous studies, that is, productivity-oriented factors, entertainment factors, esthetic values, and overall system evaluation.

Based on the UTAUT model, Šumak et al. [63] found that performance expectancy and social influence are significantly correlated with learners' attitudes toward using a VR system. Social influence and learners' attitudes were proved to have a significant influence on their behavioral

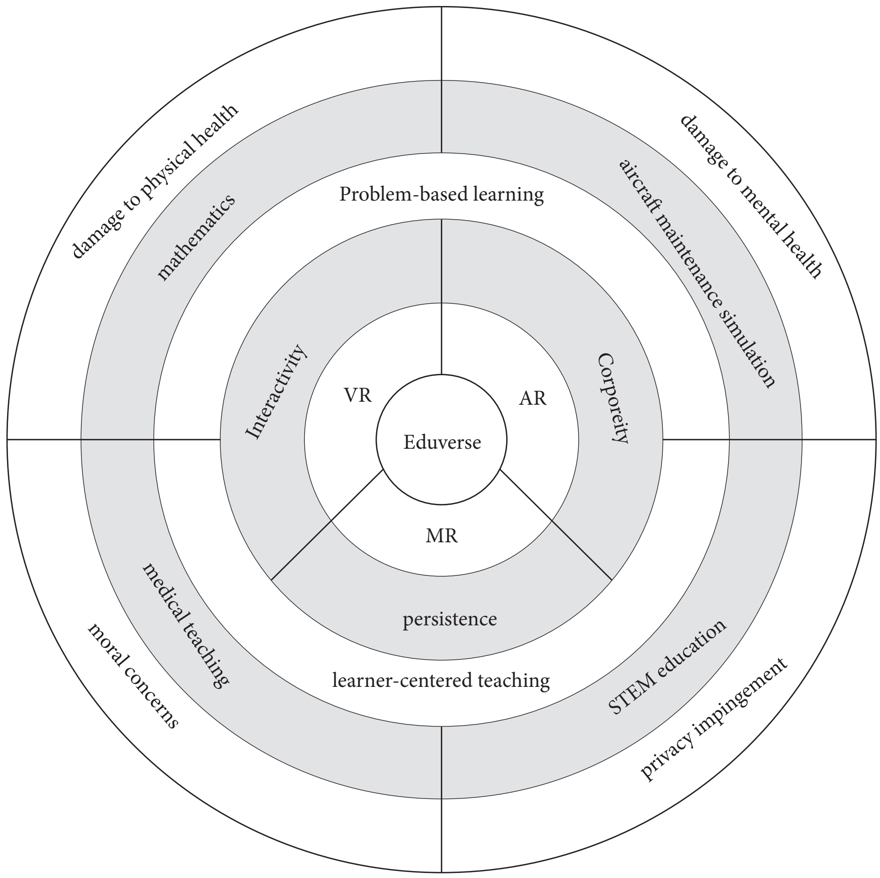

Figure 1: Educational applications of the metaverse: the Eduverse.

intention [63]. Facilitating conditions and learners' behavioral intention were shown to have significant effects on their actual use of VR [63]. Similarly, Ali et al. [64] presented that effort expectancy, performance expectancy, facilitating conditions, social influence, hedonic motivation, price value, and habit are all significantly correlated with learners' acceptance and usage of VR. Chiao et al. [65] modified the UTAUT model and found that effort expectancy, performance expectancy, social influence, and interaction directly affect learners' intention to use VR and indirectly affect their actual use of VR, whereas facilitating conditions only directly affect their actual use of VR.

In summary, although VR/AR/MR is being applied to the field of education, the technology itself is not a panacea. Jensen and Konradsen [66] proposed that the lack of content and insufficient hardware capabilities constitute two main barriers that may limit its effectiveness and reduce user acceptance. Therefore, these problems needed to be solved if Eduverse is ever to become reality [67]. Further research is also needed to investigate the determinant factors of users' adoption of Eduverse.

2.3. UTAUT: The Unified Theory of Acceptance and Use of Technology. Theories related to technology acceptance have been proposed, and various frameworks have been developed to provide insight into users' intention to adopt and behavior related to innovative technologies [68]. The evolution of technology acceptance theories has progressed since the early twentieth century and has been dominated by eight theoretical models, namely, (i) the model of PC utilization (MPCU) [69], (ii) the theory of reasoned action (TRA) [70], (iii) innovation diffusion theory (IDT) [71], (iv) the theory of planned behavior (TPB) [72], (v) the motivational model (MM) [73], (vi) the technology acceptance model (TAM) [74], (vii) social cognitive theory (SCT) [75], and (viii) a combined TPB and TAM (C-TAM-TPB) model [76]. However, these exploratory models vary widely and have limitations in terms of harmonization, which may cause confusion among researchers and those who interpret their findings [17, 32]. Therefore, Venkatesh et al. [18] integrated these older theories into a unified framework known as the UTAUT model [18].

The UTAUT model identifies four core constructs as direct determinants of users' adoption of technologies: performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC), all of which are moderated by users' age, experience, and gender, and the voluntariness of use [18]. Compared with the aforementioned eight theories, which explained 17%~42% of variance in usage intention and behaviors related to technologies, the UTAUT model, with the highest explanatory power of 70%, is more effective in analyzing technology acceptance [19].

Considering the power and effectiveness of the UTAUT, researchers have frequently employed it as a theoretical lens to conduct empirical studies on a range of technologies.

Systems examined by researchers using the UTAUT can be classified into four categories, as defined by Williams et al. [77]: (i) general-purpose systems such as information systems [78, 79], internet banking systems [80], e-government services [81], and web-based virtual M-learning systems [82]; (ii) specialized business systems such as electronic medical record systems [83] and picture archiving and communication systems [84]; (iii) communication systems such as mobile commerce [85] and automated feedback systems [86]; and (iv) office systems such as computer-assisted audit techniques [87]. Figure 2 illustrates the evolution, constructs, strengths, and applications of the UTAUT model.

Although the UTAUT model has been extensively applied to reveal factors that affect users' behavior and intention to use various technologies, it has not been utilized to explore learners' adoption of the metaverse, although this technology has provoked researchers' interests in terms of its potential application in various educational settings [88].

Until very recently, to the best of our knowledge, only two empirical studies have been conducted regarding adoption of the metaverse in educational settings. Akour et al. published a paper on February 13, 2022, that investigated the determinants of students' adoption of the Eduverse in higher educational institutions in the Gulf area [22]. Suh and Ahn published a paper on March 7, 2022, that analyzed the attitude, behavioral intention, and actual usage of the Eduverse by Korean elementary school students [27]. The empirical analyses in both papers were based on the TAM. However, the TAM has several limitations: (i) it fails to examine the relationship between usage attitude and intention; (ii) it only investigates external variables related to perceived ease of use and usefulness; and (iii) it fails to provide a comprehensive understanding of individuals' perspectives on novel technologies [23, 44, 45]. To fill this research gap, we utilize the more complete UTAUT model to test the direct effects of PE, EE, SI, and FC on learners' adoption of the Eduverse, extending the base model by incorporating perceived risk, which affects intention to use the Eduverse.

3. Theory and Hypothesis Development

3.1. The Eduverse and the UTAUT. According to the UTAUT model, the four essential determining components of usage intention are PE, EE, SI, and FC. In the context of the present study, PE represents the degree to which using the Eduverse benefits learners in performing learning activities [18]. In particular, PE is composed of four subconstructs: (i) perceived usefulness, which means that learners believe that adoption of the Eduverse can improve their learning efficiency; (ii) extrinsic motivation, which means that learners perceive added value in adopting the Eduverse; (iii) relative advantage, which captures learners' belief that adopting the Eduverse is better than using previous e-learning tools; and (iv) outcome expectation, which indicates that learners anticipate a sense of pleasure and accomplishment after using the Eduverse [89].

EE captures learners' expectations about how easy it is to use the Eduverse [18]. In particular, EE is composed of three subconstructs, including perceived ease of using the Eduverse, complexity, and actual ease of using the Eduverse [89].

SI is the extent to which learners perceive that as important as others believe they should use the Eduverse [18]. In particular, SI can be divided into four subconstructs: (i) subjective norm, which represents the influences of significant others (e.g., family members and friends) on learners' decision-making about whether to use the Eduverse; (ii) celebrity endorsement; (iii) social factors, which include the effects of cultural and social norms on learners' usage of the Eduverse; and (iv) image, which represents learners' belief that adopting the Eduverse can benefit them in improving their social image and relations [89].

FC refers to learners' perceptions of the technical and organizational resources that can support their use of the Eduverse [18]. In particular, FC includes three subconstructs: facilitating conditions, perceived behavioral control, and compatibility with the technology [89].

3.2. Satisfaction. A key motivation for users to continue using products or brands is that those products or brands meet their needs, goals, and values [90]. In marketing terms, after using a product, users develop positive or negative attitudes toward it or its brand [91]. Satisfaction strongly influences the formation of these attitudes. Most early studies on satisfaction utilized the expectation-disconfirmation model, in which users compare expected and perceived cognitive experiences to determine their own satisfaction or dissatisfaction [92, 93]. Satisfaction ensues when specific attributes of an experience perceived by users are higher than their expectations; dissatisfaction is believed to be caused by the actual experience failing to meet expectations [94, 95].

Satisfaction is an important determining factor in users' acceptance of information technologies [96, 97]. In the process of learners' using the Eduverse, PE, EE, SI, and FC directly determine the quality of their experience. Previous studies have shown that users' experience usually affects their satisfaction [91]. PE refers to the degree to which users perceive emerging technologies to improve their work performance [18]. In the field of education, metaverse provides users with a vivid and immersive learning experience, which can improve the quality of user interaction with virtual elements. In this way, Eduverse enables users to effectively handle learning tasks [98]. The users of Eduverse will have a more positive evaluation of the platform because of the improvement in their learning efficiency. Therefore, we present the following hypothesis:

> *H*1: Performance expectancy positively affects learners' satisfaction with the Eduverse.

The ease of use of new technologies is another determining factor of user satisfaction [99]. In the Eduverse platform, knowledge is easier to understand since it is realistically displayed through virtual reality and other interactive technologies. Moreover, the Eduverse platform

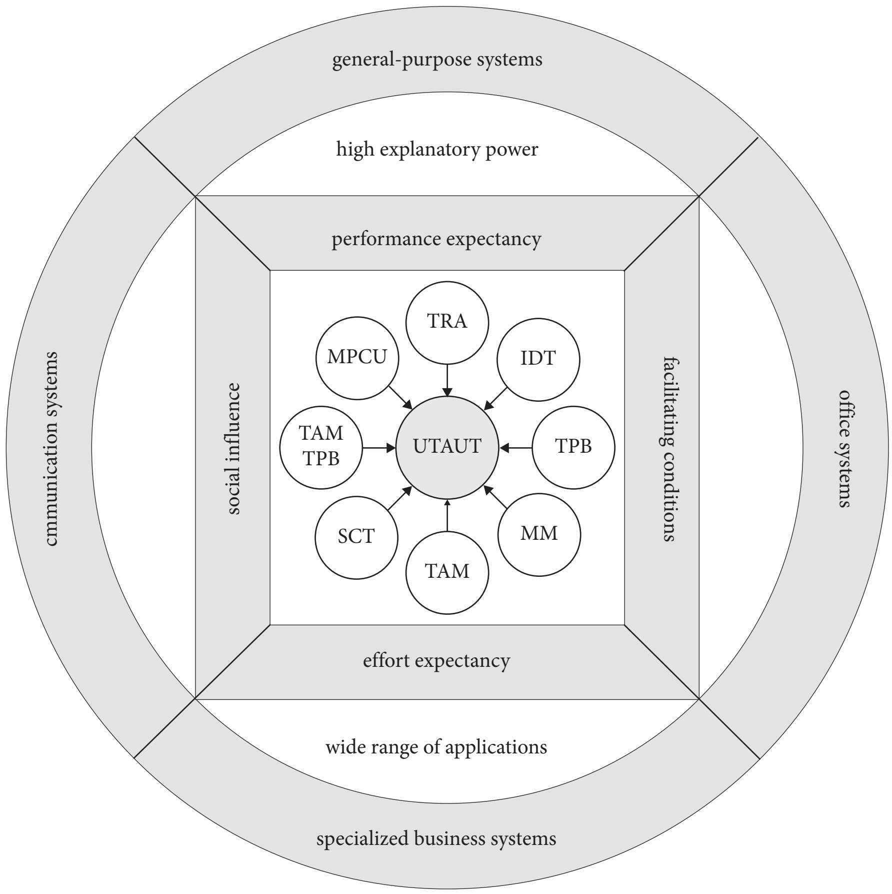

Figure 2: The unified theory of acceptance and use of technology (UTAUT) model. Note: TRA represents the theory of reasoned action, IDT represents the innovation diffusion theory, TPB represents the theory of planned behavior, MM represents the motivational model, TAM represents the technology acceptance model, SCT represents the social cognitive theory, TAM-TPB represents a combined TPB and TAM, and MPCU represents the model of PC utilization.

itself is built by imitating the real world. Even in the virtual world, users can learn in a way that is in accordance with their prior experiences, so they are more likely to be satisfied with the easy usage of Eduverse. Therefore, we present the following hypothesis:

H2: Effort expectancy positively affects learners' satisfaction with the Eduverse.

As for the SI, in some studies, social influence is considered to be similar to social norms [100]. People's behavior is influenced by their social groups. People use products and brands that they believe are a good match for them and represent who they are in the eyes of others [101]. Consumption in line with social norms satisfies the social needs of consumers. Therefore, we present the following hypothesis:

H3: Social influence positively affects learners' satisfaction with the Eduverse.

FC refers to the expected level of organizational and technical infrastructure that can support the use of technology [18]. In the process of using the Eduverse platform, whether users can get immediate support can affect their evaluation of it [102]. That is, if users can get the help provided by the platform in the face of any possible difficulties, they will have a positive evaluation of the platform. Therefore, we present the following hypothesis:

H4: Facilitating conditions positively affect learners' satisfaction with the Eduverse.

3.3. Continued Usage Intention. The empirical study of Fornell et al. [98] showed that satisfaction has a strong impact on users' repeated purchase of services or goods. According to expectation confirmation theory, users' continued intention to purchase a certain product or service largely depends on their satisfaction with previous purchases; low satisfaction may lead users not to use the product or service anymore [99]. At the same time, with the improvement of information systems, many empirical studies have tested factors that affect users' intention to continue to use a certain information system based on satisfaction [103, 104]. For example, Deng developed and tested a research model to investigate the effects of users' experiences with information technology on their satisfaction with and continued intention to use the technology [102]. Jin et al. [105] conducted an empirical study to investigate why users continue to answer questions in online communities, similarly finding that users' continued intention to use these forums was directly influenced by their satisfaction. Therefore, we present the following hypothesis:

*H*5: Learners' satisfaction with the Eduverse positively affects their intention to continue using it.

3.4. Perceived Risk. The concept of perceived risk was first proposed by Bauer in 1960 and has since been widely used in various research studies [106, 107]. In the context of electronic services, perceived risk is usually defined as possible loss, such as psychological loss or loss of property or privacy, when the expected result is produced [108]. The web and mobile platforms are considered risky and uncertain because they are vulnerable to hacking and information leaks; this risk and uncertainty influence user behaviors [89] and increase pressure during decision-making. As a result, people tend to avoid such risk [109], choosing to stay away from its sources. Therefore, even if users are satisfied with a product in the process of using it, their trust in the service provider may be compromised due to perceived risk, thus affecting their intention to continue using it [110]. Therefore, we present one final hypothesis:

*H*6: Learners' intention to continue to use the Eduverse will be reduced due to perceived risk.

4. Research Methodology

4.1. Measures. All scales were developed based on the constructs mentioned in the literature review above. PE, EE, FC, SI, and continued usage intention were measured using three items based on the scales of Madigan et al. [111]. Satisfaction was measured using three items based on the scales of Shiv and Huber [112]. Perceived risk was measured using three items taken from the scales of Wei et al. [89].

4.2. Survey Procedure and Data Collection. The procedure of our experiment was as follows. First, we performed a pretest to ensure the reliability of our questionnaire items. There were 45 pretest participants chosen among Chinese university students majoring in marketing who provided feedback about the questionnaire, based on which we amended the questionnaire and created our final formal survey. Second, to collect data, we recruited volunteers who were willing to participate in our experiment from a university in China in which smart classrooms are equipped with holographic projectors.

Third, we invited a well-known smart classroom construction company to explain the concept, features, usage methods, and application effects of the smart classroom to the students. Students viewed several application scenarios of technologies related to Eduverse such as 5G, VR, AR, and MR in future educational settings by means of PowerPoint presentations and video demonstrations. The reason that we asked this company to explain Eduverse was that it was responsible for the construction and design of the smart classroom; therefore, its technical descriptions would be more professional. To ensure that its explanations fit our research theme, we discussed and approved all the information given by the company.

Fourth, the subjects were required to answer the questionnaire after the presentation. In the questionnaire, participants were first asked whether they understood the educational metaverse platform. They were then asked to rate the technology on scales related to PE, EE, SI, FC, satisfaction, continued intention to use the technology, perceived risk, and continued intention to use the technology depending on perceived risk. Demographic information was also collected on subjects' gender, age, income, and occupation.

Finally, 552 questionnaires were collected, and after deleting the responses of 34 respondents who indicated that they did not understand the Eduverse, we utilized 495 valid questionnaires in the analysis. RMB 2 was paid to each participant, and after finishing the questionnaire, all participants received gift certificates. The validity of the developed scales was tested by the principal component analysis using SPSS 22.0, and Amos 24.0 was used to test our measures and structural model.

4.3. Demographics. In the main survey, 495 completed questionnaires were included in the analysis. Specific demographic information for all respondents is shown in Table 1. The research subjects were mostly undergraduate students under the age of 20 or between 21 and 30 years old, although the sample also included 9 master's and doctoral students. The respondents were mainly women ($n = 341$, 68.9%).

5. Empirical Results

5.1. Model. In order to verify the reliability and validity of the measures used in this study, we calculated Cronbach's α and conducted a principal component analysis. The results are shown in Table 2.

SEM and Amos 21 were used to analyze the research data. The model showed a good fit for the sample data ($\chi^2 = 376.541$, df = 120, $\chi^2/\text{df} = 3.138$, $p < 0.05$, comparative fit index (CFI) = 0.970, normed fit index (NFI) = .957, Tucker–Lewis index (TLI) = 0.962, root mean square error of approximation (RMSEA) = 0.066, and root mean residual (RMR) = 0.089).

Construct validity was determined by calculating convergent and discriminant validities. The results for the model are shown in Table 3. All items showed convergent validity with statistically significant ($p < 0.01$) factor loadings [113] and standardized factor loadings above 0.70 with critical ratios above 2.57 [114].

The discriminant validity of the measured constructs was assessed as suggested by Fornell and Larcker [114]. The results showed that the square root of the average variance extracted (AVE) for each factor was greater than its correlation with other factors, as presented in Table 4. Therefore, discriminant validity was supported for all pairs of constructs.

Table 1: Demographic characteristics of research participants.

Description		Frequency	Percent
Gender	Male	154	31.1
	Female	341	68.9
Age	≤20	212	42.8
	21–30	274	55.4
	31–40	9	1.8
	41–50	0	0
	≥51	0	0
Monthly household income	<RMB 3000	133	26.9
	RMB 3000–6000	190	38.4
	RMB 6000–9000	28	5.6
	>RMB 9000	45	9.1
Total		495	100.0

Table 2: Results of component analysis.

Construct	Item	Component						Cronbach's α
		1	2	3	4	5	6	
Usage intention	UI2	0.870	0.115	0.170	0.165	0.093	0.222	0.912
	UI3	0.848	0.171	0.171	0.116	0.133	0.166	
	UI1	0.834	0.033	0.217	0.203	0.058	0.245	
Social influence	SI2	0.133	0.845	0.199	0.204	0.246	0.170	0.925
	SI1	0.100	0.801	0.220	0.259	0.245	0.125	
	SI3	0.140	0.766	0.256	0.218	0.267	0.146	
Satisfaction	S3	0.233	0.285	0.794	0.211	0.234	0.201	0.932
	S2	0.261	0.248	0.779	0.227	0.199	0.253	
	S1	0.258	0.221	0.752	0.238	0.300	0.165	
Performance expectancy	PE2	0.175	0.215	0.187	0.831	0.231	0.174	0.902
	PE3	0.166	0.306	0.277	0.760	0.203	0.173	
	PE1	0.260	0.205	0.172	0.729	0.230	0.276	
Effort expectancy	EP2	0.112	0.353	0.264	0.250	0.786	0.207	0.922
	EP3	0.098	0.352	0.237	0.254	0.781	0.242	
	EP1	0.173	0.318	0.271	0.261	0.739	0.265	
Facilitating conditions	FC2	0.330	0.086	0.108	0.132	0.177	0.825	0.881
	FC3	0.161	0.184	0.204	0.189	0.216	0.801	
	FC1	0.278	0.186	0.265	0.295	0.182	0.699	
Eigenvalue		2.798	2.785	2.526	2.526	2.501	2.451	
Variance explained		15.546	15.474	14.034	14.032	13.892	13.617	
Variance (cumulative)		15.546	31.021	45.055	59.087	72.979	86.596	

5.2. Testing Hypotheses on Structural Model. The results of the test of the overall structural model indicate a good model fit ($\chi^2 = 459.401$, df = 124, $\chi^2/\text{df} = 3.705$, $p < 0.05$, CFI = 0.961, NFI = 0.948, TLI = 0.952, RMSEA = 0.074, and RMR = 0.128). The results of hypothesis testing are shown in Table 5. All hypotheses were accepted. First, hypothesis 1, which explored whether performance expectancy positively contributes to learner' s satisfaction with the Eduverse, is supported ($H1$, C.R. = 3.732, p = 0.000). Second, the results show that effort expectancy positively contributes to learner' s satisfaction with the Eduverse ($H2$, C.R. = 3.002, p = 0.003). Third, both social influence ($H3$, C.R. = 4.026, p = 0.000) and facilitating conditions ($H4$, C.R. = 5.604, p = 0.000) positively affect learners' satisfaction with the Eduverse. In addition, learners' satisfaction with the Eduverse shows positive effects on their intention to continue using it ($H5$, C.R. = 13.579, p = 0.000).

5.3. Effect of Perceived Risk. After carrying out the first step of determining intention to continue using this technology, we reminded respondents that they needed to input personal information, including their names, mobile phone numbers, school numbers, and student numbers, for verification when logging on to the metaverse educational platform. Then, we measured perceived risk. Finally, we conducted a second analysis of intention to continue using the technology and calculated the difference between the responses before and after the introduction of perceived risk. Respondents were then classified according to perceived risk. In an independent sample t-test, a significant difference in mean values was found between intention to continue using the platform before ($M = -0.323$) and after ($M = -0.897$) learning about perceived risk ($t = 5.197$, $p < 0.05$) (see Figure 3). This indicates that the learners' desire to continue to use it decreased after they perceived the risk. Although they may

Table 3: Results of measurement model.

Construct and item	SL	SE	CR	*P*-value
Performance expectancy (PE)				
PE1: I find the metaverse educational platform to be useful for my study purposes.	0.826	N/A	N/A	0.000
PE2: Using the metaverse educational platform makes it easier for me to achieve my study goals.	0.898	0.046	24.307	0.000
PE3: Using the metaverse educational platform improves my learning efficiency.	0.887	0.047	23.925	0.000
Social influence (SI)				
SI1: People who are important to me would think that I should use the metaverse educational platform.	0.852	N/A	N/A	0.000
SI2: People whose opinions I value would like me to use the metaverse educational platform.	0.911	0.038	27.434	0.000
SI3: People who influence my behavior would think that I should use the metaverse educational platform.	0.927	0.039	28.267	0.000
Effort expectancy (EE)				
EE1: My interaction with the metaverse educational platform is clear and understandable.	0.908	N/A	N/A	0.000
EE2: I think the metaverse educational platform is easy to use.	0.949	0.030	37.297	0.000
EE3: Learning to use the metaverse educational platform is easy for me.	0.942	0.030	36.548	0.000
Facilitating conditions (FC)				
FC1: There are online resources to show me how to use the metaverse educational platform.	0.865	N/A	N/A	0.000
FC2: There are online customer service providers to show me how to use the metaverse educational platform.	0.837	0.042	22.559	0.000
FC3: There are online customer service providers to help me when I have difficulties with using the metaverse educational platform.	0.824	0.044	22.061	0.000
Satisfaction (S)				
S1: I feel satisfied while experiencing the metaverse educational platform.	0.871	N/A	N/A	0.000
S2: I feel happy while experiencing the metaverse educational platform.	0.918	0.034	29.652	0.000
S3: I feel good while experiencing the metaverse educational platform.	0.934	0.025	30.629	0.000
Usage intention (UI)				
UI1: I intend to continue to use the metaverse educational platform.	0.882	N/A	N/A	0.000
UI2: I want to continue to use the metaverse educational platform.	0.926	0.037	28.952	0.000
UI3: I would like to continue to use the metaverse educational platform.	0.839	0.041	24.722	0.000

Note. SL, bootstrap standardized loadings; SE, standard error; CR, critical ratio.

Table 4: Results of correlation analysis and discriminant validity assessment.

AVE	FE	EE	FC	SI	S	UI
FE	0.758					
EE	0.702 (0.493)	0.871				
FC	0.660 (0.436)	0.651 (0.424)	0.709			
SI	0.680 (0.463)	0.790 (0.624)	0.550 (0.303)	0.805		
S	0.681 (0.464)	0.708 (0.501)	0.659 (0.434)	0.685 (0.469)	0.825	
UI	0.535 (0.286)	0.418 (0.175)	0.652 (0.425)	0.409 (0.167)	0.593 (0.352)	0.780

Note. Figures on diagonal line represent AVE, and figures in parentheses are squares of correlation coefficients.

Table 5: Results of hypothesis testing.

Hypothesis	Path	Estimate	SE	C.R.	*P*	Results
*H*1	PE ⟶ S	0.234	0.063	3.732	0.000	Accepted
*H*2	EE ⟶ S	0.168	0.056	3.002	0.003	Accepted
*H*3	SI ⟶ S	0.210	0.052	4.026	0.000	Accepted
*H*4	FC ⟶ S	0.321	0.057	5.604	0.000	Accepted
*H*5	S ⟶ UI	0.523	0.039	13.579	0.000	Accepted

have been satisfied with the Eduverse platform, their willingness to continue to use it decreased after perceiving the risk.

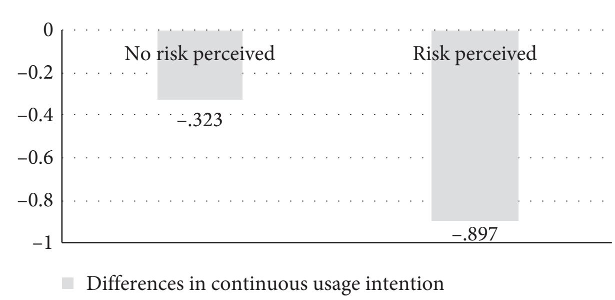

Figure 3: Differences in continued usage intention before and after learning of the possible risk.

6. Discussion and Conclusions

This study based on the UTAUT model examined factors affecting learners' adoption of and intention to continue using an educational metaverse platform in China. We also assessed the effect of perceived risk on learners' intention to continue using the platform through SEM. In a sample of 495 questionnaire responses collected from students at a university in China, performance expectancy, effort expectancy, social influence, and facilitating conditions had significantly positive effects on learners' satisfaction with the Eduverse. In line with the findings of previous research, we verified that learners' satisfaction has a positive effect on their intention to continue using the technology. In addition, the effect of perceived risk was also confirmed. After reminding learners of the risks, such as the need to provide personal information when registering on an Eduverse platform, even those with high satisfaction showed less inclination to continue using the Eduverse platform.

Our research results provided significant theoretical and practical contributions. Regarding theoretical contributions, first, our study is a pioneering study, which explores the adoption of Eduverse from learners' point of view based on the UTAUT model. Previous studies on the determinants of learners' adoption of the Eduverse have been based on the TAM model [22, 27]; however, this study provides empirical evidence of the validity of the more integrated and effective UTAUT model in explaining learners' adoption of the Eduverse. In this way, our study extends our knowledge in the field of adoption of Eduverse. Second, we extended the base model by incorporating perceived risk, which was found to reduce learners' intention to continue using the Eduverse platform despite their satisfaction with it. In this way, our results complement those of existing studies using technology acceptance theories. Third, the focus of this study is on the application of metaverse in the educational field. A promising avenue for further research is to explore the application of metaverse in other fields, such as entertainment industry, government services, tourism industry, and agricultural sector.

Regarding practical contributions, we demonstrated that PE, EE, FC, and SI, important constructs from the UTAUT, all had positive impacts on learners' satisfaction with the Eduverse; this is similar to the findings of Ali et al. [64] and Chiao et al. [65]. Based on the findings of the present study, Eduverse is an increasingly crucial method of learning for students. In the process of management, customers and their satisfaction are of great significance to the long-term sustainable development of enterprises. Therefore, it is particularly important to improve the PE, EE, SI, and FC of the Eduverse platform as follows.

First, from the practical point of view, enterprises should, therefore, prioritize practicality and convenience when developing Eduverse platforms. The practicality of the Eduverse and the various resources and conditions provided by enterprises for learners on this platform influenced learners' acceptance of it, and also their satisfaction with it. Therefore, the Eduverse must be developed to meet learning requirements and provide convenience. In addition, further attention should be paid to platform maintenance and timely handling of user feedback in the platform management process.

Second, the results of this study also confirm the impact of effort expectancy on satisfaction and continued usage intention. Making the virtual environment clearer and the instructions simpler in the process of learning how to use an Eduverse platform must also be considered by platform developers and operators.

Third, the significantly positive effect of SI on satisfaction and continued usage intention may indicate that Chinese students' use of Eduverse platforms is influenced by specific social groups. In other words, the people that surround users are often important in deciding which platforms they choose. This is the situation in China: teachers, schools, and training institutions often designate specific learning platforms for students. Therefore, in terms of marketing strategy, service providers should be sure to cooperate with schools and institutions. In addition, the social impact of the Eduverse also deserves attention. Online word of mouth and friend recommendations should also be considered.

Fourth, the significantly positive effect of FC on satisfaction and continued usage intention indicates that educational infrastructure is important for learning. Students who do not have access to Eduverse technologies due to lack of financial resources or other restrictions should not be ignored. Educational institutions and governments should provide them with organizational and technological resources to reduce educational inequality.

Fifth, another concern is perceived risk, which proved to play an important role in this study. Service providers require users to enter basic personal information such as mobile phone numbers when registering. However, in the process of use, alleviating users' doubts and reducing perceived risk are an urgent problem that remains to be solved. Privacy pledges may help to some extent.

Sixth, even though our empirical investigations were conducted in the context of China, our study can provide meaning implications to be applied to other societies for international audience. China is not the only country in the world that vigorously develops Eduverse platforms. Universities in other countries are also building educational metaverse platforms for applications such as virtual laboratories and virtual campus life. With the further improvement of technology, students not only participate in classroom activities through face-to-face teaching or 2D online learning, but the Eduverse can provide students with a more immersive and convenient way to participate in classes. The virtual learning environment provided by the Eduverse is easier to meet the needs of students who have a preference for novel and interesting teaching tools. Therefore, all educational institutions in the world can attempt to open courses for students all over the world by building Eduverse platforms to promote the dissemination of knowledge. Future research endeavors should investigate whether our research results still hold in other countries.

This study has several limitations that pave the way for further productive research in the future. First, the subjects of this study were Chinese university students; the results may, therefore, not be applicable to students in high school and below. Therefore, future researchers may wish to examine the factors influencing intention to continue using Eduverse platforms for students from a wider variety of educational settings.

Second, considering most of the respondents to our questionnaire were women (68.9%), the results of our empirical analysis may potentially have a gender bias. Further study should attempt to include a more balanced representation of learners' gender distribution.

Third, due to the low application and popularity of metaverse-related technologies in educational settings, the students who completed our survey had limited exposure to Eduverse technologies. Further studies can include those with more experience with Eduverse technologies in their target population. Moreover, another promising avenue for further research is to examine how or to what extent the Eduverse affects classroom activities. This issue can be examined through longitudinal evaluation, for example, experiments can be conducted using an experimental group that learns through Eduverse technology for a period of time and a control group that learns through traditional educational technologies.

Fourth, since our experiment was conducted in a university where students are exposed to the same hardware devices, their existing experiences related to Eduverse are supposed to be at the same level. Under this setting of our experiment, it is hard for us to control the level of existing related experiences in order to examine factors that affect learner satisfaction in the metaverse environment. However, experience level is an important moderating variable in technology acceptance and numerous studies have found that users with different level of experience placed a different emphasis on the determinants of usage and intention [76, 115–118]. Therefore, the role of experience deserves further examination in the future.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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References

[1] S. Dhawan, "Online learning: a panacea in the time of COVID-19 crisis," *Journal of Educational Technology Systems*, vol. 49, no. 1, pp. 5–22, 2020.

[2] S. Hrastinski, "Asynchronous and synchronous e-learning," *Educause Quarterly*, vol. 31, no. 4, pp. 51–55, 2008.

[3] S. Mystakidis, "Metaverse," *Metaverse, " Encyclopedia*, vol. 2, no. 1, pp. 486–497, 2022.

[4] C. Stöhr, C. Demazière, and T. Adawi, "The polarizing effect of the online flipped classroom," *Computers & Education*, vol. 147, Article ID 103789, 2020.

[5] D. S. Stein, C. E. Wanstreet, and J. Calvin, "How a novice adult online learner experiences transactional distance," *Quarterly Review of Distance Education*, vol. 10, no. 3, p. 305, 2009.

[6] Z. Libasin, A. R. Azudin, N. A. Idris, M. S. Abdul Rahman, and N. Umar, "Comparison of students' academic performance in mathematics course with synchronous and asynchronous online learning environments during COVID-19 crisis," *International Journal of Academic Research in Progressive Education and Development*, vol. 10, no. 2, pp. 492–501, 2021.

[7] K. Jordan, "Initial trends in enrolment and completion of massive open online courses," *International Review of Research in Open and Distance Learning*, vol. 15, no. 1, pp. 133–160, 2014.

[8] A. Lepp, J. E. Barkley, A. C. Karpinski, and S. Singh, "College students' multitasking behavior in online versus face-to-face courses," *Sage Open*, vol. 9, no. 1, Article ID 215824401882450, 2019.

[9] J. Y. Hong, J. He, B. Lam, R. Gupta, and W.-S. Gan, "Spatial audio for soundscape design: recording and reproduction," *Applied Sciences*, vol. 7, no. 6, p. 627, 2017.

[10] A. T. Maereg, A. Nagar, D. Reid, and E. L. Secco, "Wearable vibrotactile haptic device for stiffness discrimination during virtual interactions," *Frontiers in Robotics and AI*, vol. 4, p. 42, 2017.

[11] S. Mystakidis, "Combat tanking in education: the TANC model for playful distance learning in social virtual reality," *International Journal of Gaming and Computer-Mediated Simulations*, vol. 13, no. 4, pp. 28–47, 2021.

[12] K. Choi, Y.-J. Yoon, O.-Y. Song, and S.-M. Choi, "Interactive and immersive learning using 360 virtual reality contents on mobile platforms," *Mobile Information Systems*, vol. 2018, Article ID 2306031, 2018.

[13] T. Im, I. Yun, and S.-Y. Kim, "Holistic haptic education platform for developmental disorder children," *International Journal of Applied Engineering Research*, vol. 12, no. 17, pp. 6615–6622, 2017.

[14] S.-Y. Kim, B.-S. Shin, and H. Choi, "Virtual reality based education with mobile device platform," *Mobile Information Systems*, vol. 2019, p. 1, 2019.

[15] D. M. Barry, H. Kanematsu, Y. Fukumura, and N. Ogawa, "International comparison for problem based learning in metaverse," *The ICEE and ICEER*, vol. 6066, 2009.

[16] H. Kanematsu, T. Kobayashi, N. Ogawa, Y. Fukumura, D. M. Barry, and H. Nagai, "Nuclear energy safety project in metaverse," in *Intelligent Interactive Multimedia: Systems and Services*, pp. 411–418, Springer, Berlin, Germany, 2012.

[17] J. Shin and S.-Y. Kim, *Immersive Virtual Training for Vocational Training High School Students' Milling Machine Practice*, Springer, Cham, pp. 1019–1026, 2021.

[18] V. Venkatesh, M. G. Morris, G. B. Davis, and F. D. Davis, "User Acceptance of Information Technology: Toward a Unified View," *MIS Quarterly*, vol. 27, no. 3, pp. 425–478, 2003.

[19] C.-M. Chao, "Factors determining the behavioral intention to use mobile learning: an application and extension of the UTAUT model," *Frontiers in Psychology*, vol. 10, p. 1652, 2019.

[20] A. M. Momani, "The unified theory of acceptance and use of technology: a new approach in technology acceptance," *International Journal of Sociotechnology and Knowledge Development*, vol. 12, no. 3, pp. 79–98, 2020.

[21] N. Friesen, *The Textbook and the Lecture: Education in the Age of New media*, JHU Press, Baltimore, USA, 2017.

[22] I. A. Akour, R. S. Al-Maroof, R. Alfaisal, and S. A. Salloum, "A conceptual framework for determining metaverse adoption in higher institutions of gulf area: an empirical study using hybrid SEM-ANN approach," *Computers & Education: Artificial Intelligence*, vol. 3, Article ID 100052, 2022.

[23] J. Díaz, C. Saldaña, and C. Avila, "Virtual world as a resource for hybrid education," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 15, no. 15, pp. 94–109, 2020.

[24] E. De Graaf and A. Kolmos, "Characteristics of problem-based learning," *International Journal of Engineering Education*, vol. 19, no. 5, pp. 657–662, 2003.

[25] S. Farjami, R. Taguchi, K. T. Nakahira, R. Nunez Rattia, Y. Fukumura, and H. Kanematsu, *Multilingual Problem Based Learning in Metaverse*, pp. 499–509, Kolkata, India, 2011.

[26] S. O. Bada and S. Olusegun, "Constructivism learning theory: a paradigm for teaching and learning," *Journal of Research & Method in Education*, vol. 5, no. 6, pp. 66–70, 2015.

[27] W. Suh and S. Ahn, "Utilizing the metaverse for learner-centered constructivist education in the post-pandemic era: an analysis of elementary school students," *Journal of Intelligence*, vol. 10, no. 1, p. 17, 2022.

[28] M. Wangid, H. Rudyanto, and G. Gunartati, "The Use of AR-Assisted Storybook to Reduce Mathematical Anxiety on Elementary School Students," *International Journal of Interactive Mobile Technologies*, vol. 14, 2020.

[29] H. Lee, D. Woo, and S. Yu, "Virtual reality metaverse system supplementing remote education methods: based on aircraft maintenance simulation," *Applied Sciences*, vol. 12, no. 5, Article ID 2667, 2022.

[30] E. Jeon, M. Laura, B. Lorraine et al., "Emergency remote learning in nursing education during the COVID-19 pandemic," in *Public Health and Informatics*, pp. 942–946, IOS Press, Amsterdam, Netherlands, 2021.

[31] H. Kanematsu, T. Kobayashi, D. M. Barry, Y. Fukumura, A. Dharmawansa, and N. Ogawa, "Virtual STEM class for nuclear safety education in metaverse," *Procedia Computer Science*, vol. 35, pp. 1255–1261, 2014.

[32] N. Pellas, S. Mystakidis, and I. Kazanidis, "Immersive Virtual Reality in K-12 and Higher Education: a systematic review of the last decade scientific literature," *Virtual Reality*, vol. 25, no. 3, pp. 835–861, 2021.

[33] M. Slater, C. Gonzalez-Liencres, P. Haggard et al., "The ethics of realism in virtual and augmented reality," *Frontiers in Virtual Reality*, vol. 1, no. 1, 2020.

[34] B. Kye, N. Han, E. Kim, Y. Park, and S. Jo, "Educational applications of metaverse: possibilities and limitations," *Journal of Educational Evaluation for Health Professions*, vol. 18, p. 32, 2021.

[35] A. Christopoulos, S. Mystakidis, N. Pellas, and M.-J. Laakso, "ARLEAN: an augmented reality learning analytics ethical framework," *Computers*, vol. 10, no. 8, p. 92, 2021.

[36] S. Shen, K. Xu, M. Sotiriadis, and Y. Wang, "Exploring the factors influencing the adoption and usage of Augmented Reality and Virtual Reality applications in tourism education within the context of COVID-19 pandemic," *Journal of Hospitality, Leisure, Sports and Tourism Education*, vol. 30, Article ID 100373, 2022.

[37] M. Speicher, B. D. Hall, and M. Nebeling, "What Is Mixed Reality?" in *Proceedings of the CHI Conference on Human Factors in Computing Systems*, pp. 1–15, Glasgow, Scotland, UK, May 2019.

[38] J. Mütterlein, "The three pillars of virtual reality? Investigating the roles of immersion, presence, and interactivity," in *Proceeding of the presented at the 51st Hawaii international conference on system sciences*, Hawaii, January 2018.

[39] J. Liang, "Factors Impacting Virtual or Augmented Reality Effectiveness in Training and Education Factors Impacting Virtual or Augmented Reality Effectiveness in Training and Education," in *Proceeding of the Presented at the Inter service Industry, Training, Simulation, and Education Conference 2020*, Orlando, FL, January 2021.

[40] C. Rasimah, M. Nurazean, M. Salwani, M. Norziha, and I. Roslina, "A systematic literature review of factors influencing acceptance on Mixed Reality technology," *ARPN Journal of Engineering and Applied Sciences*, vol. 10, no. 23, Article ID 18239, 2015.

[41] R. M. Baños, C. Botella, M. Alcañiz, V. Liaño, B. Guerrero, and B. Rey, "Immersion and emotion: their impact on the sense of presence," *CyberPsychology and Behavior*, vol. 7, no. 6, pp. 734–741, 2004.

[42] M. Slater and S. Wilbur, "A framework for immersive virtual environments (FIVE): speculations on the role of presence in virtual environments," *Presence: Teleoperators and Virtual Environments*, vol. 6, no. 6, pp. 603–616, 1997.

[43] D. Allcoat, T. Hatchard, F. Azmat, K. Stansfield, D. Watson, and A. von Mühlenen, "Education in the digital age: learning experience in virtual and mixed realities," *Journal of Educational Computing Research*, vol. 59, no. 5, pp. 795–816, 2021.

[44] J. A. Fredricks, P. C. Blumenfeld, and A. H. Paris, "School engagement: potential of the concept, state of the evidence," *Review of Educational Research*, vol. 74, no. 1, pp. 59–109, 2004.

[45] J. Hamari, D. J. Shernoff, E. Rowe, B. Coller, J. Asbell-Clarke, and T. Edwards, "Challenging games help students learn: an empirical study on engagement, flow and immersion in game-based learning," *Computers in Human Behavior*, vol. 54, pp. 170–179, 2016.

[46] M. J. Maas and J. M. Hughes, "Virtual, augmented and mixed reality in K–12 education: a review of the literature," *Technology, Pedagogy and Education*, vol. 29, no. 2, pp. 231–249, 2020.

[47] T. Reiners, L. C. Wood, and T. J. Bastiaens, "New landscapes and new eyes: the role of virtual world design for supply chain education," *Ubiquitous Learning: An International Journal*, vol. 6, no. 1, pp. 37–49, 2014.

[48] R. Lindgren, M. Tscholl, S. Wang, and E. Johnson, "Enhancing learning and engagement through embodied interaction within a mixed reality simulation," *Computers & Education*, vol. 95, pp. 174–187, 2016.

[49] M. M. Asad, A. Naz, P. Churi, A. J. M. Guerrero, and A. A. Salameh, "Mix method approach of measuring VR as a

pedagogical tool to enhance experimental learning: motivation from literature survey of previous study," *Educational Research International*, vol. 2022, Article ID 8262304, 9 pages, 2022.

[50] P. Aiello, F. D'elia, S. Di Tore, and M. Sibilio, "A constructivist approach to virtual reality for experiential learning," *E-learning and Digital Media*, vol. 9, no. 3, pp. 317–324, 2012.

[51] B. Marks and J. Thomas, "Adoption of Virtual Reality Technology in Higher Education: An Evaluation of Five Teaching Semesters in a Purpose-Designed Laboratory," *Education and Information Technologies*, vol. 27, pp. 1–19, 2021.

[52] Y.-M. Tang, K. M. Au, H. C. W. Lau, G. T. S. Ho, and C.-H. Wu, "Evaluating the effectiveness of learning design with mixed reality (MR) in higher education," *Virtual Reality*, vol. 24, no. 4, pp. 797–807, 2020.

[53] B. Marks and J. Thomas, "Adoption of virtual reality technology in higher education: an evaluation of five teaching semesters in a purpose-designed laboratory," *Education and Information Technologies*, vol. 27, no. 1, pp. 1287–1305, 2022.

[54] N. Tegoan, S. Wibowo, and S. Grandhi, "Application of the extended reality technology for teaching new languages: a systematic review," *Applied Sciences*, vol. 11, no. 23, Article ID 11360, 2021.

[55] J. Vora, S. Nair, A. K. Gramopadhye, A. T. Duchowski, B. J. Melloy, and B. Kanki, "Using virtual reality technology for aircraft visual inspection training: presence and comparison studies," *Applied Ergonomics*, vol. 33, no. 6, pp. 559–570, 2002.

[56] S.-A. A. Jin, "'I can be happy even when I lose the game': the influence of chronic regulatory focus and primed self-construal on exergamers' mood," *Cyberpsychology, Behavior, and Social Networking*, vol. 13, no. 4, pp. 467–471, 2010.

[57] H.-M. Sun, S.-P. Li, Y.-Q. Zhu, and B. Hsiao, "The effect of user's perceived presence and promotion focus on usability for interacting in virtual environments," *Applied Ergonomics*, vol. 50, pp. 126–132, 2015.

[58] M. E. Portman, A. Natapov, and D. Fisher-Gewirtzman, "To go where no man has gone before: virtual reality in architecture, landscape architecture and environmental planning," *Computers, Environment and Urban Systems*, vol. 54, pp. 376–384, 2015.

[59] V. Potkonjak, M. Gardner, V. Callaghan et al., "Virtual laboratories for education in science, technology, and engineering: a review," *Computers & Education*, vol. 95, pp. 309–327, 2016.

[60] Y.-J. Kim and S.-Y. Ahn, "Factors influencing nursing students' immersive virtual reality media technology-based learning," *Sensors*, vol. 21, no. 23, p. 8088, 2021.

[61] N. Singh and M. J. Lee, "Exploring perceptions toward education in 3-D virtual environments: an introduction to 'second life," *Journal of Teaching in Travel & Tourism*, vol. 8, no. 4, pp. 315–327, 2009.

[62] F. Abd Majid and N. Mohd Shamsudin, "Identifying factors affecting acceptance of virtual reality in classrooms based on Technology Acceptance Model (TAM)," *Asian Journal of University Education*, vol. 15, no. 2, pp. 51–10, 2019.

[63] B. Šumak, G. Polancic, and M. Hericko, "An empirical study of virtual learning environment adoption using UTAUT," in *Second International Conference on Mobile*, pp. 17–22, Hybrid, and On-Line Learning, 2010.

[64] F. Ali, P. K. Nair, and K. Hussain, "An assessment of students' acceptance and usage of computer supported collaborative classrooms in hospitality and tourism schools," *Journal of Hospitality, Leisure, Sports and Tourism Education*, vol. 18, pp. 51–60, 2016.

[65] H.-M. Chiao, Y.-L. Chen, and W.-H. Huang, "Examining the usability of an online virtual tour-guiding platform for cultural tourism education," *Journal of Hospitality, Leisure, Sports and Tourism Education*, vol. 23, pp. 29–38, 2018.

[66] L. Jensen and F. Konradsen, "A review of the use of virtual reality head-mounted displays in education and training," *Education and Information Technologies*, vol. 23, no. 4, pp. 1515–1529, 2018.

[67] D.-I. D. Han, Y. Bergs, and N. Moorhouse, "Virtual reality consumer experience escapes: preparing for the metaverse," *Virtual Reality*, vol. 2022, pp. 1–16, 2022.

[68] A. M. Momani and M. Jamous, "The evolution of technology acceptance theories," *International Journal of Contemporary Computer Research (IJCCR)*, vol. 1, no. 1, pp. 51–58, 2017.

[69] H. C. Triandis, "Values, attitudes, and interpersonal behavior," *Nebraska Symposium on Motivation*, vol. 27, 1979.

[70] I. Azjen, *Understanding Attitudes and Predicting Social Behavior*, Englewood Cliffs, 1980.

[71] E. M. Rogers, *Diffusion of Innovations*, Free Press, New York, 1983.

[72] I. Ajzen, "From intentions to actions: a theory of planned behavior," in *Action Control*, pp. 11–39, Springer, Berlin, Germany, 1985.

[73] E. Deci and R. M. Ryan, *Intrinsic Motivation and Self-Determination in Human Behavior*, Springer US, New York Heidelberg, 1985.

[74] F. D. Davis, "A Technology Acceptance Model for Empirically Testing New End-User Information Systems: Theory and Results," Ph. D Thesis, Massachusetts Institute of Technology, Cambridge, UK, 1985.

[75] C. J. Heffernan, "Social foundations of thought and action: a social cognitive theory, Albert Bandura Englewood Cliffs, New Jersey: prentice Hall, 1986, xiii + 617 pp. Hardback. US$39.50," *Behaviour Change*, vol. 5, no. 1, pp. 37-38, 1988.

[76] S. Taylor and P. A. Todd, "Understanding information technology usage: a test of competing models," *Information Systems Research*, vol. 6, no. 2, pp. 144–176, 1995.

[77] M. D. Williams, N. P. Rana, and Y. K. Dwivedi, "The unified theory of acceptance and use of technology (UTAUT): a literature review," *Journal of Enterprise Information Management*, vol. 28, no. 3, pp. 443–488, 2015.

[78] T. Teo and J. Noyes, "An assessment of the influence of perceived enjoyment and attitude on the intention to use technology among pre-service teachers: a structural equation modeling approach," *Computers & Education*, vol. 57, no. 2, pp. 1645–1653, 2011.

[79] V. Venkatesh, S. A. Brown, L. M. Maruping, and H. Bala, "Predicting different conceptualizations of system use: the competing roles of behavioral intention, facilitating conditions, and behavioral expectation," *MIS Quarterly*, vol. 32, no. 3, pp. 483–502, 2008.

[80] E. AbuShanab and J. M. Pearson, "Internet banking in Jordan: the unified theory of acceptance and use of technology (UTAUT) perspective," *Journal of Systems and Information Technology*, vol. 9, no. 1, pp. 78–97, 2007.

[81] G. Rodrigues, J. Sarabdeen, and S. Balasubramanian, "Factors that influence consumer adoption of e-government services in the UAE: a UTAUT model perspective," *Journal of Internet Commerce*, vol. 15, no. 1, pp. 18–39, 2016.

[82] S. H. Alshammari, "Exploring the factors that influence students' behavioral intention to use M-learning," *Multicultural Education*, vol. 7, no. 9, 2021.
[83] K. B. Shiferaw and E. A. Mehari, "Modeling predictors of acceptance and use of electronic medical record system in a resource limited setting: using modified UTAUT model," *Informatics in Medicine Unlocked*, vol. 17, Article ID 100182, 2019.
[84] B. Pynoo, P. Devolder, T. Voet, L. Adang, J. Vercruysse, and P. Duyck, "User acceptance of a picture archiving and communication system," *Methods of Information in Medicine*, vol. 47, no. 02, pp. 149–156, 2008.
[85] M. I. R. Mousa Jaradat and M. S. Al Rababaa, "Assessing key factor that influence on the acceptance of mobile commerce based on modified UTAUT," *International Journal of Business and Management*, vol. 8, no. 23, p. 102, 2013.
[86] J. C. W. Debuse, M. Lawley, and R. Shibl, "Educators' perceptions of automated feedback systems," *Australasian Journal of Educational Technology*, vol. 24, no. 4, 2008.
[87] J. Bierstaker, D. Janvrin, and D. J. Lowe, "What factors influence auditors' use of computer-assisted audit techniques?" *Advances in Accounting*, vol. 30, no. 1, pp. 67–74, 2014.
[88] A. Parmaxi, "Virtual reality in language learning: a systematic review and implications for research and practice," *Interactive Learning Environments*, pp. 1–13, 2020.
[89] M.-F. Wei, Y.-H. Luh, Y.-H. Huang, and Y.-C. Chang, "Young generation's mobile payment adoption behavior: analysis based on an extended UTAUT model," *Journal of Theoretical and Applied Electronic Commerce Research*, vol. 16, no. 4, pp. 618–636, 2021.
[90] J. Kim, S. Forsythe, Q. Gu, and S. Jae Moon, "Cross-cultural consumer values, needs and purchase behavior," *Journal of Consumer Marketing*, vol. 19, no. 6, pp. 481–502, 2002.
[91] N.-H. Choi, Q. M. Nguyen, and Z. Teng, "Effects of performance, imagery and regulatory focus on customer engagement," *Journal of Distribution Science*, vol. 17, no. 1, pp. 57–72, 2019.
[92] J. L. Giese and J. A. Cote, "Defining consumer satisfaction," *Academy of Marketing Science Review*, vol. 1, no. 1, pp. 1–22, 2000.
[93] R. Veenhoven, "Developments in satisfaction-research," *Social Indicators Research*, vol. 37, no. 1, pp. 1–46, 1996.
[94] V. McKinney, K. Yoon, and F. M. Zahedi, "The measurement of web-customer satisfaction: an expectation and disconfirmation approach," *Information Systems Research*, vol. 13, no. 3, pp. 296–315, 2002.
[95] V. Venkatesh and S. Goyal, "Expectation Disconfirmation and Technology Adoption: Polynomial Modeling and Response Surface Analysis," *MIS Quarterly*, pp. 281–303, 2010.
[96] G. Kabra, A. Ramesh, P. Akhtar, and M. K. Dash, "Understanding behavioural intention to use information technology: insights from humanitarian practitioners," *Telematics and Informatics*, vol. 34, no. 7, pp. 1250–1261, 2017.
[97] M. Koufaris and W. Hampton-Sosa, "The development of initial trust in an online company by new customers," *Information Management*, vol. 41, no. 3, pp. 377–397, 2004.
[98] C. Fornell, M. D. Johnson, E. W. Anderson, J. Cha, and B. E. Bryant, "The American customer satisfaction index: nature, purpose, and findings," *Journal of Marketing*, vol. 60, no. 4, pp. 7–18, 1996.
[99] M. Han, J. Wu, Y. Wang, and M. Hong, "A model and empirical study on the user's continuance intention in online China brand communities based on customer-perceived benefits," *Journal of Open Innovation: Technology, Market, and Complexity*, vol. 4, no. 4, p. 46, 2018.
[100] N. J. Goldstein and R. B. Cialdini, "Using social norms as a lever of social influence," in *The Science of Social Influence*, pp. 167–191, Psychology Press, London, UK, 2011.
[101] N.-H. Choi and Z. Teng, "Roles of social identity verification in the effects of symbolic and evaluation relevance on Chinese consumers' brand attitude," *The East Asian Journal of Business Management*, vol. 8, no. 4, pp. 17–27, 2018.
[102] L. Deng, D. E. Turner, R. Gehling, and B. Prince, "User experience, satisfaction, and continual usage intention of IT," *European Journal of Information Systems*, vol. 19, no. 1, pp. 60–75, 2010.
[103] I. Hidayat-ur-Rehman, A. Ahmad, M. N. Khan, and S. A. Mokhtar, "Investigating mobile banking continuance intention: a mixed-methods approach," *Mobile Information Systems*, vol. 2021, Article ID 9994990, 2021.
[104] Y. Wu, F. Gu, Y. Ji, J. Guo, and Y. Fan, "Technological capability, eco-innovation performance, and cooperative R&D strategy in new energy vehicle industry: evidence from listed companies in China," *Journal of Cleaner Production*, vol. 261, Article ID 121157, 2020.
[105] X.-L. Jin, Z. Zhou, M. K. Lee, and C. M. Cheung, "Why users keep answering questions in online question answering communities: a theoretical and empirical investigation," *International Journal of Information Management*, vol. 33, no. 1, pp. 93–104, 2013.
[106] R. A. Bauer, "Consumer behavior as risk taking," in *Proceedings of the Dynamic Marketing for a Changing World, Proceedings of the 43rd Conference of the American Marketing Association*, pp. 389–398, Chicago, 1960.
[107] L. Zhou, W. Wang, J. D. Xu, T. Liu, and J. Gu, "Perceived information transparency in B2C e-commerce: an empirical investigation," *Information & Management*, vol. 55, no. 7, pp. 912–927, 2018.
[108] K. B. Murray, "A test of services marketing theory: consumer information acquisition activities," *Journal of Marketing*, vol. 55, no. 1, pp. 10–25, 1991.
[109] M.-H. Huang, "Information load: its relationship to online exploratory and shopping behavior," *International Journal of Information Management*, vol. 20, no. 5, pp. 337–347, 2000.
[110] J.-W. Lian and T.-M. Lin, "Effects of consumer characteristics on their acceptance of online shopping: comparisons among different product types," *Computers in Human Behavior*, vol. 24, no. 1, pp. 48–65, 2008.
[111] R. Madigan, T. Louw, M. Wilbrink, A. Schieben, and N. Merat, "What influences the decision to use automated public transport? Using UTAUT to understand public acceptance of Automated Road Transport Systems," *Transportation Research Part F: Traffic Psychology and Behaviour*, vol. 50, pp. 55–64, 2017.
[112] B. Shiv and J. Huber, "The impact of anticipating satisfaction on consumer choice," *Journal of Consumer Research*, vol. 27, no. 2, pp. 202–216, 2000.
[113] J. C. Anderson and D. W. Gerbing, "Structural equation modeling in practice: a review and recommended two-step approach," *Psychological Bulletin*, vol. 103, no. 3, pp. 411–423, 1988.
[114] C. Fornell and D. F. Larcker, "Evaluating structural equation models with unobservable variables and measurement error," *Journal of Marketing Research*, vol. 18, no. 1, pp. 39–50, 1981.
[115] H.-L. Liao and H.-P. Lu, "The role of experience and innovation characteristics in the adoption and continued use of

e-learning websites," *Computers & Education*, vol. 51, no. 4, pp. 1405–1416, 2008.
[116] H. M. Selim, "Critical success factors for e-learning acceptance: confirmatory factor models," *Computers & Education*, vol. 49, no. 2, pp. 396–413, 2007.
[117] V. Venkatesh, J. Y. L. Thong, and X. Xu, "Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology," *MIS Quarterly*, vol. 36, no. 1, pp. 157–178, 2012.
[118] M. Zhang, Y. Liu, W. Yan, and Y. Zhang, "Users' continuance intention of virtual learning community services: the moderating role of usage experience," *Interactive Learning Environments*, vol. 25, no. 6, pp. 685–703, 2017.