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Investigation into Virtual Reality Using the Unified Theory of Acceptance and Use of Technology as a Basis

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In recent years, virtual reality (VR) technology has experienced significant growth, transforming how users interact with digital environments. However, the widespread adoption of VR has encountered challenges, mainly due to varying levels of user acceptance and usage. In this study, we delved into the application of the Unified Theory of Acceptance and Use of Technology (UTAUT) in the context of VR technology. The aim was to thoroughly examine the factors influencing the user acceptance of VR, providing a comprehensive view of this technological advancement. Using the UTAUT framework, we investigated four principal components relevant to the adoption of VR technology: performance expectancy, effort expectancy, social influence, and facilitating conditions. We examined how users perceived the performance and effort required to use VR, as well as the impact of social factors and supportive conditions on their acceptance or rejection of VR technology. A survey method was employed for this research, with questionnaires distributed in September 2023. The survey included 262 participants from Taiwan. The results showed that more than half of the respondents believe that VR can make work or study more efficient. Additionally, over half of the participants expressed willingness to invest time in learning skills and knowledge related to VR.

1. Introduction

Virtual reality (VR) refers to a technology that employs computer technology to generate a simulated 3D environment in which users can immerse and interact. The inception of VR technology dates back to the 1960s, initiated by Professor Ivan Sutherland of the United States, who developed the earliest head-mounted display (HMD). This technology laid the foundation for the development of VR.[1]

Utilizing VR technology requires wearing a VR helmet, also known as an HMD. This device not only presents images from the virtual environment but also tracks the user's head movements and posture using integrated sensors to create a realistic perspective. In addition, other accessories such as handles, gestures, and sounds are also needed to interact.

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Advanced VR technology can help students study more effectively by enhancing engagement and enthusiasm and by creating an optimum learning environment for vocabulary acquisition.[2] VR technology usually requires powerful hardware support tools, such as high-speed processors, graphics cards, and sensors, so that users can have a smooth experience in the virtual world. In addition, developing VR applications also requires mastering corresponding software development skills, including 3D modeling, programming, and animation production.

VR holds great potential for applications in education and entertainment.[2] With its ongoing technological evolution, VR is now employed across various sectors such as gaming, education, healthcare, design,[3] entertainment, industry, and the military. In these fields, VR technology is utilized for simulation and training purposes, helping to minimize risks and costs while enhancing efficiency and effectiveness.[4]

The novelty of virtual technology has always piqued the interest of users.[5] As technology progresses, the experience offered by VR is becoming increasingly lifelike, enabling users to engage in it more deeply and immersively. For example, designers can use VR technology to design and test product prototypes, doctors can use VR technology for surgical simulation and training, and military personnel can use VR technology for battlefield simulations and exercises and to experience exciting games in virtual amusement parks or in VR.[6]

In the past few years, VR technology has attracted significant attention and usage, particularly in the gaming and entertainment sectors. Many large game companies have begun to actively develop VR games and launch corresponding devices, such as Oculus, HTC, Vivo, Sony, and PlayStation VR. In addition, VR technology is also used in education, design, medical, and other fields, bringing new simulation and training methods to these fields. In general, the progress and implementation of VR technology are reshaping the lifestyles and workplaces of individuals, and it is expected to maintain a significant role in the years to come.

VR integrates graphics, sound, video, animation, and interactive equipment such that it has three characteristics:

- Imagination: Through computer-generated virtual images and sound and light effects, users can imagine themselves in a virtual space.
- Interaction: In addition to the presentation of simulated scenes, users can interact with virtual scene objects through different input devices (such as HMDs, data gloves, and position trackers), and the system generates appropriate real-time responses.
- Immersion: The virtual scene is combined with various input devices to satisfy and integrate various senses into it.

1.1 Research purposes

The aim of this study was to examine the suitability and determining elements of the Unified Theory of Acceptance and Use of Technology (UTAUT) model within the context of VR to comprehend how individuals perceive and are inclined to adopt VR technology.

The specific research purposes include the following:

- To assess the reliability of the UTAUT model in VR settings: Examine the effectiveness of the UTAUT model in forecasting acceptance and willingness to use VR. Investigate the predictive capability of UTAUT model constructs such as perceived usefulness, perceived ease of use, social influence, and usage intention in relation to VR acceptance.
- To determine the critical elements influencing the acceptance of VR: Investigate the pivotal factors contributing to VR acceptance, encompassing aspects such as user experience, perceived utility, ease of use, and social influence, among others. Understand the mechanisms and relative importance of these factors on VR acceptance.
- To compare the acceptance of VR by different user groups: Study the acceptance and willingness to use VR by different user groups, such as the impact of factors such as age, gender, and education level. Compare the differences between different user groups to understand the attitudes and needs of different users towards VR.
- To explore the application scope and potential value of VR: Study the application of VR in specific fields (such as education, medical care, and training) and evaluate its acceptance and potential value. Understand the user needs, challenges, and advantages of VR in different application scenarios.
- To provide suggestions for promoting and improving the acceptance of VR: Based on the research results, propose relevant promotion strategies and improvement suggestions to promote the acceptance and willingness to use VR.

1.2 Research motivation

The UTAUT model serves as a commonly utilized framework for elucidating individuals' inclination to accept and adopt emerging technologies. VR, being an emerging and promising technology, has attracted considerable interest and practical applications. Therefore, we conducted special research on UTAUT and VR based on the following motivations:

- Address the research void: Despite the extensive validation of the UTAUT model across various domains, its exploration within the realm of VR has been somewhat limited. Hence, undertaking dedicated research on the intersection of UTAUT and VR can bridge this research gap, offering a comprehensive insight into the effectiveness and relevance of the UTAUT model in the context of VR.
- Encourage the utilization and advancement of VR: As an emerging technology, VR holds significant potential across various domains, including education, healthcare, and gaming, among others. Investigating the connection between the UTAUT model and VR enables us to gain profound insights into individuals' reception and readiness to embrace VR. This research can offer valuable insights to steer the application and growth of related fields effectively.
- Enhance the user experience in VR: Achieving the successful implementation of VR necessitates a thorough consideration of user requirements and their overall experience. The

UTAUT model offers a structured approach to assess user acceptance and intention to use, allowing for a deeper understanding of user attitudes and the factors that influence their perception of VR. Exploring the connection between UTAUT and VR enables us to offer recommendations for refining the user experience in VR, ultimately boosting its usability and acceptance.

- Promote the development of relevant theories: By conducting applied research on the UTAUT model within the realm of VR, the model can be extended and adjusted to align with the distinctive attributes and determinants of VR. Such adaptation can contribute to the advancement of pertinent theories and serve as a basis and point of reference for subsequent research endeavors.

2. Literature Review

2.1 UTAUT

UTAUT, which stands for the Unified Theory of Acceptance and Use of Technology, serves as a theoretical framework employed to elucidate individuals' willingness to accept and utilize technology. This theory comprises four components: perceived utility, perceived ease of use, subjective norms, and perceived control. Each of these facets exerts an influence on individuals' actions regarding the acceptance and utilization of technology.

In the course of investigating the UTAUT model, numerous researchers have undertaken extensive studies to examine the influence of UTAUT on the acceptance and usage patterns of diverse technologies. The ensuing section provides an overview of pertinent literature concerning the UTAUT model.

Venkatesh *et al.* introduced the initial rendition of UTAUT to investigate how individuals embrace and engage with information systems.[7] They posited that perceived utility, perceived ease of use, subjective norms, and perceived control constitute the principal determinants shaping individuals' inclinations and behaviors regarding information systems acceptance and utilization.[7] Venkatesh and Bala explored the impact of UTAUT on the acceptance and use behavior of Internet technology in their study.[8] They believe that the four aspects of UTAUT can effectively explain people's acceptance and use of Internet technology. Chao employed the UTAUT model in their research to investigate how Chinese university students perceive and engage with online learning.[9] Their findings revealed that perceived utility, perceived ease of use, and perceived control exerted a substantial and favorable influence on students' acceptance and engagement with online learning.[9] Bu *et al.* (2021) explored the impact of UTAUT on the acceptance and usage behavior of digital learning platforms in China in their study.[10] They found that perceived usefulness, perceived ease of use, subjective norms, and perceived control have significant positive effects on students' behavior in using digital learning platforms.[10]

Overall, UTAUT is an effective theoretical framework for explaining people's acceptance and use behavior of technology. Scholars apply UTAUT in different fields and with different technologies.

2.2 VR

VR is an environment that simulates human sensory experience through computer technology. In such an environment, people can interact with virtual objects or virtual characters. With the development of technology, VR has been widely used in entertainment, education, training, and other fields. The student in the experimental groups generally lacked prior exposure to VR and had limited time for both acquainting themselves with the technology and concentrating on vocabulary development.[11] The following is a discussion of some relevant literature on VR.

Tibaldi *et al.* explored the application of VR in education, especially the impact on students' learning outcomes and learning experience.[12] Their research results showed that VR can enhance students' learning motivation and interest, and improve students' learning efficiency and memory effects.[12] Zhang *et al.* discussed the application of VR in military training.[13] They found that VR can provide a highly realistic battlefield experience, allowing soldiers to conduct actual training in a virtual environment, thereby improving actual combat capabilities and reaction speed.[13] Slater and Wilbur explored the application of VR in therapy. They found that VR can be used to treat psychological diseases such as anxiety and post-traumatic stress disorder, and can effectively improve the effectiveness of treatment.[14] Zhang *et al.* explored the application of VR in sports training.[15] They found that VR can provide an immersive sports experience, allowing athletes to train in a virtual environment to improve their athletic abilities and skills.[15]

Overall, VR is a technology with vast potential for application across diverse fields, including education, training, and healthcare. As technology continues to advance and refine, VR is anticipated to become increasingly prevalent and accessible, offering considerable convenience and enjoyment to individuals in the future.

2.3 Digital twins in retail industry

Digital twins, primarily utilized in practical settings such as virtual dressing rooms, establish a connection with the physical environment through sophisticated visualization techniques, in-depth analysis, and the use of sensors.[16] This innovation animates dynamic character behaviors and instructions, making the virtual try-on experience more lifelike and seamless, thereby significantly enhancing customer engagement.[17,18] VR technology usually requires powerful hardware support tools, such as high-speed processors, graphics cards, and sensors, so that users can have a smooth experience in the virtual world. Incorporating augmented reality, VR, and mobile applications into retail environments presents a valuable opportunity to elevate the shopping experience for consumers.[19] These digital tools blend virtual elements with real-world settings, resulting in a more interactive and enjoyable shopping journey. Furthermore, the digitalization and adoption of advanced technologies in store management can assist employees in efficiently handling routine tasks.[20,21]

3. Method

The focus revolves around the intersection of UTAUT (Fig. 1) and VR, employing techniques such as literature analysis and questionnaire surveys. The approach involves the random sampling of both participants and data.

3.1 Research mode

In this study, we used UTAUT to study the acceptance and use of VR (Fig. 2) among Taiwanese university students. According to UTAUT, four factors influence the use of VR, as follows.

Perceived usefulness: This refers to the perception that users have about whether VR technology can have real benefits for their work, study or life. This includes whether users believe that VR technology can improve productivity, provide a better learning experience, improve medical treatment, and provide other functions. Perceived utility plays a pivotal role in influencing a user's inclination to embrace VR technology, as users are more inclined to utilize VR when they perceive it as delivering tangible value.

Perceived ease of use: Users' assessments of the ease of acquiring and operating VR technology are crucial. This encompasses whether users find it straightforward and instinctive to engage with VR technology and whether it demands substantial time and effort to acquire the necessary skills. When users perceive VR technology as user-friendly, their inclination to utilize it may increase.

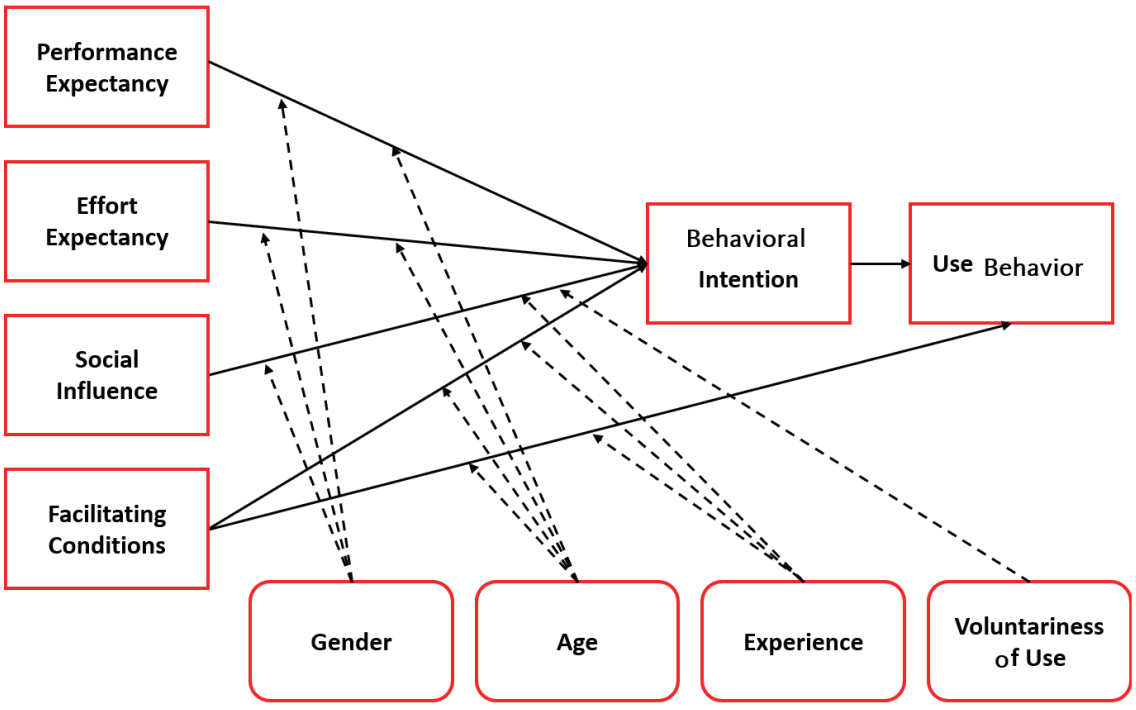

Fig. 1. (Color online) UTAUT model.

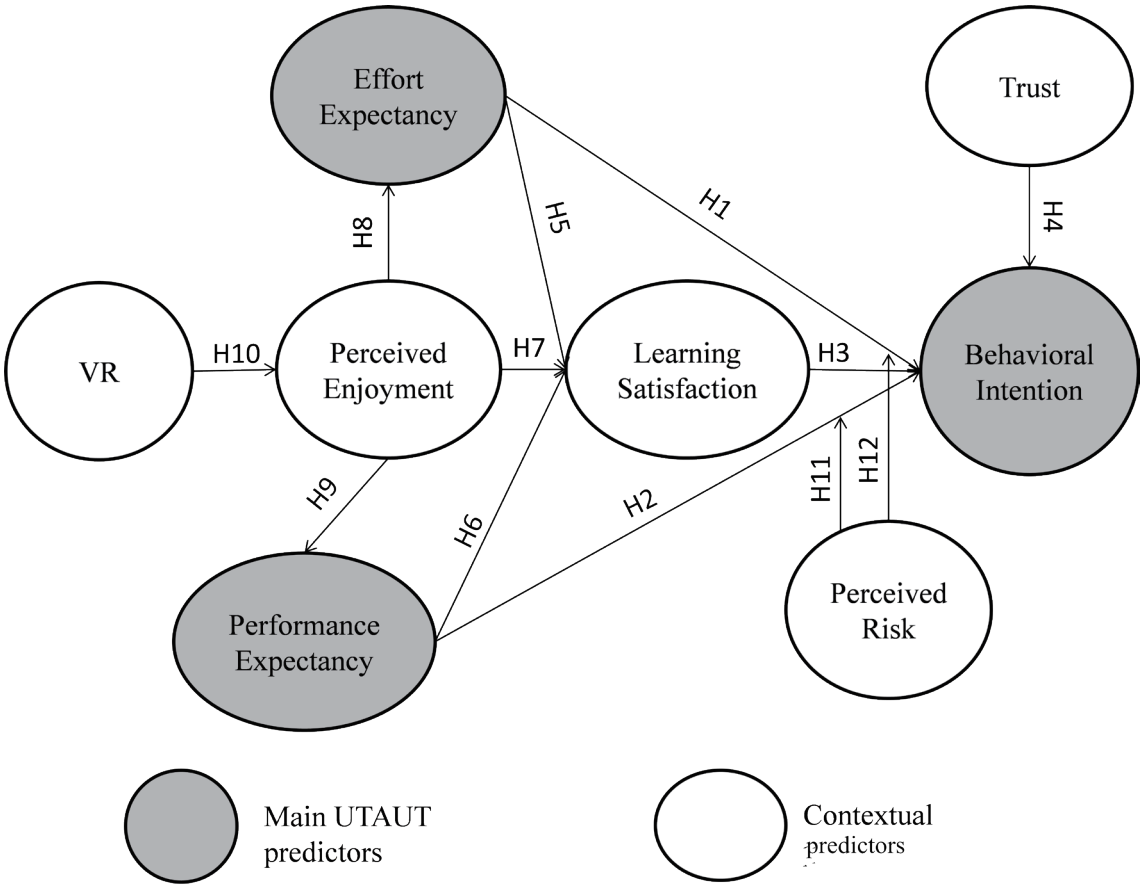

Fig. 2. Conceptualized extended UTAUT model for measuring Taiwanese students' acceptance of VR learning.

Subjective norms: Subjective norms pertain to the extent to which a user is swayed by the viewpoints and anticipations of others, which can include colleagues, family members, friends, and so on. Users are more likely to try VR if they perceive that the people around them support and encourage the use of VR technology. The influence of the social environment is very important for the adoption of VR technology, as other people's perceptions and behaviors can influence the user's decision-making.

Perceived behavioral control: Perceived behavioral control relates to the user's assurance and capability to manage and operate VR technology effectively. Users are more inclined to experiment with VR technology when they believe they possess the requisite skills and resources for its usage. In addition, the user's confidence in overcoming possible obstacles and difficulties will also influence whether or not they are willing to use VR technology.

Hypothesis 1: EE positively influences university students' BIs towards the adoption of VR learning.

Hypothesis 2: PE significantly influences university students' BIs towards the adoption of VR learning.

Hypothesis 3: Satisfaction significantly influences university students' BIs towards the adoption of VR learning.
Hypothesis 4: Trust significantly influences university students' BIs towards the adoption of VR learning.
Hypothesis 5: EE significantly influences satisfaction towards VR learning.
Hypothesis 6: PE significantly influences satisfaction towards VR learning.
Hypothesis 7: Perceived enjoyment significantly influences satisfaction towards VR learning.
Hypothesis 8: Perceived enjoyment significantly influences EE towards VR learning.
Hypothesis 9: Perceived enjoyment significantly influences PE towards VR learning.
Hypothesis 10: Mobile self-efficacy significantly influences perceived enjoyment towards VR learning.

(H1) Higher Engagement (EE) positively influences university students' willingness to use VR learning, with a coefficient of −1.090* (p-value = 0.000).
(H2) Perceived Ease of Use (PE) has a positive impact on university students' inclination to adopt VR learning, but with a coefficient of 0.145 (p-value = 0.331).
(H3) Satisfaction contributes positively to the propensity of university students to embrace VR learning, with a coefficient of 0.759* (p-value = 0.000).
(H4) Trust plays a positive role in university students' willingness to use VR learning, with a coefficient of 1.051* (p-value = 0.000).
(H5) EE has a positive influence on satisfaction with VR learning, with a coefficient of 0.221* (p-value = 0.000).
(H6) PE positively impacts satisfaction with VR learning, with a coefficient of 0.515* (p-value = 0.000).
(H7) Perceived enjoyment contributes positively to satisfaction with VR learning, with a coefficient of 0.704* (p-value = 0.000).
(H8) Perceived enjoyment positively influences the level of EE in VR learning, with a coefficient of 0.920* (p-value = 0.000).
(H9) Perceived enjoyment positively influences the level of PE in VR learning, with a coefficient of 0.924* (p-value = 0.000).
(H10) VR technology has a positive impact on the perceived enjoyment of VR learning, with a coefficient of 0.544* (p-value = 0.000).

The conclusion of VR research is based on the results of existing research, summarizing the impact, applications, and future development trends of VR in various fields. Owing to the wide range of research fields in VR, different studies may come to different conclusions. Here are a few examples of possible VR research conclusions.
VR in education: Research shows that VR has great potential in education, providing immersive learning experiences that enhance student engagement and memory. VR alleviates anxiety toward public speaking.[22] However, some students have expressed apprehension about potential embarrassment in classrooms settings.[23] Instructors have the ability to construct immersive

scenarios using VR, which can provide students with a more profound comprehension of abstract ideas and foster their problem-solving and teamwork abilities. Incorporating VR into language learning provides learners with authenticity and customization by immersing them in environments where the target language is used. This allows for interactions with native speakers and leads to noteworthy advances in educational outcomes.[24]

VR in healthcare: Studies have shown that VR has significant effects on medical diagnosis, treatment, and rehabilitation. It can be used in areas such as pain management, mental health treatment, surgical simulation, and occupational therapy. VR not only alleviates patient suffering, but also helps healthcare professionals improve their skills and diagnostic capabilities.

VR and social interaction: Studies indicate that VR plays a significant role in facilitating social interactions, offering users a platform to engage with friends and family from a distance, as well as forming virtual social networks that expand their social connections. Nonetheless, challenges and issues arise when it comes to the interaction between the virtual realm and the physical world.

VR for creative and entertainment applications: Studies showed that VR creates new possibilities in fields such as art, design, and entertainment. It can be used to create engaging virtual games, art displays, and music experiences. The aesthetic and narrative features of VR have also received considerable attention.

Challenges and future development of VR technology: Studies showed that VR still faces many technical challenges, such as graphics rendering, motion tracking, and the perceived realism of VR. However, as technology continues to advance, VR is expected to be more widely used in the future and have a significant impact in various fields.

In conclusion, VR research depends on different research angles and methods, but they all reflect the potential and challenges of VR technology, as well as its far-reaching impact on society and various industries. VR offers an environment that is not only more authentic and multidimensional but also enriched with motor interactions, making it conducive to effective language acquisition.[25] As science and technology progress and research delves deeper into e-learning, the potential applications of VR will continue to grow and undergo transformation.

3.2 Assumptions

The UTAUT model consolidates the aforementioned eight theoretical models and forms the fundamental factor influencing usage intent.[7] Among the four primary determinants, performance expectations, effort expectations, and social influence strongly anticipate this intent. The UTAUT model aligns well with the context of our study, leading us to formulate hypotheses on the basis of these observations.(Fig. 3)

Hypothesis 1: Enhanced performance expectations result in a favorable impact on users' readiness to embrace VR.

Hypothesis 2: Anticipated benefits exert a positive influence on users' inclination to adopt VR.

Hypothesis 3: Social influence positively affects users' willingness to engage with VR.

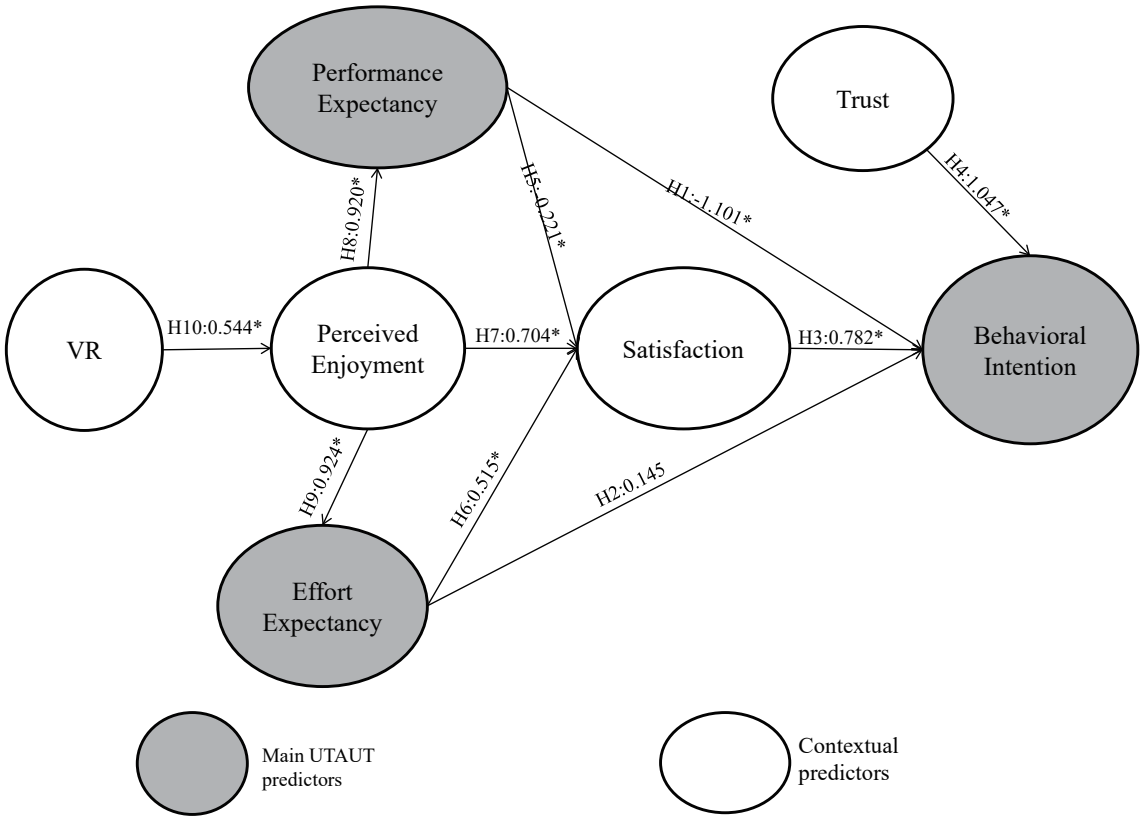

Fig. 3. Path diagram for partial model (H1–H10).

Hypothesis 4: The convenience offered by VR correlates positively with actual usage by users.
Hypothesis 5: Users' behavioral intent to utilize VR is positively linked to their actual usage of the technology.

PE1: The utilization of a VR system enhances my learning outcomes.
PE2: Engaging with a VR system boosts my motivation for learning.
PE3: The use of a VR system enhances my performance in educational activities.
PE4: I perceive the use of a VR system as valuable for my academic studies.

EE1: I would perceive it as straightforward to use a VR system.
EE2: I would find it easy to acquire proficiency in using a VR system.
EE3: Becoming skilled in utilizing a VR system would come naturally to me.
EE4: My learning activities with a VR system are lucid and comprehensible.

SI1: Individuals who hold significance in my life believe I should incorporate a VR system into my learning.
SI2: Those who influence my learning choices advocate for my use of a VR system.
SI3: Both my peers and teachers endorse the idea of me using a VR system.
SI4: I consider the use of a VR system to be a fashionable choice.

FC1: I possess the necessary resources to effectively engage with a VR system.
FC2: I possess the requisite knowledge to operate a VR system competently.
FC3: I believe that using a VR system aligns well with my preferred learning style.
FC4: In the event of encountering challenges with a VR system, I am confident in my ability to swiftly resolve them.

BI1: I have the intention to incorporate a VR system into my future learning endeavors.
BI2: I envision using a VR system as a means to enhance my English skills.
BI3: I have plans to integrate a VR system into my learning within the next two months.

4. Results: Data collection method

The objective of this research was to gain insights into users' perspectives, encounters, and contentment concerning VR applications. In July 2023, a survey was administered using Google online forms, and respondents' usage levels were evaluated using a five-point Likert scale. The scale was structured with 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree (Tables 1–4).

Table 1
Construct reliability and validity.

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
BI	0.832	0.833	0.882	0.599
EE	0.799	0.799	0.882	0.714
En	0.716	0.717	0.841	0.638
PE	0.713	0.714	0.839	0.635
Sa	0.523	0.588	0.744	0.499
trust	0.850	0.863	0.893	0.627

Table 2
Discriminant validity.

	BI	EE	En	PE	Sa	trust
BI						
EE	1.019					
En	1.025	1.044				
PE	0.934	0.929	1.036			
Sa	0.662	0.651	0.920	0.909		
trust	0.978	1.010	1.045	0.968	0.797	

Table 3
Fornell Larcker criterion

	BI	EE	En	PE	Sa	trust
BI	0.774					
EE	0.831	0.845				
En	0.789	0.789	0.799			
PE	0.721	0.704	0.743	0.797		
Sa	0.472	0.462	0.610	0.602	0.707	
trust	0.829	0.839	0.813	0.744	0.552	0.792

Table 4
Cross loadings.

	BI	EE	En	PE	Sa	trust
BI5	0.783	0.665	0.597	0.552	0.333	0.693
BI1	0.767	0.632	0.601	0.572	0.329	0.608
BI2	0.781	0.666	0.594	0.490	0.311	0.634
BI3	0.765	0.620	0.647	0.590	0.390	0.620
BI4	0.772	0.631	0.615	0.585	0.463	0.651
EE1	0.665	0.799	0.696	0.657	0.402	0.662
EE2	0.726	0.875	0.680	0.575	0.415	0.740
EE3	0.714	0.859	0.619	0.548	0.351	0.724
En3	0.586	0.588	0.811	0.622	0.617	0.630
En1	0.647	0.632	0.763	0.570	0.450	0.658
En2	0.662	0.674	0.822	0.587	0.384	0.660
PE1	0.543	0.509	0.547	0.795	0.490	0.583
PE2	0.601	0.585	0.615	0.800	0.506	0.574
PE3	0.575	0.586	0.612	0.796	0.444	0.621
Sa1	0.238	0.220	0.263	0.241	0.554	0.253
Sa2	0.467	0.476	0.571	0.577	0.836	0.520
Sa3	0.232	0.210	0.386	0.373	0.701	0.333
trust 2	0.693	0.702	0.673	0.558	0.400	0.801
trust 3	0.616	0.665	0.649	0.641	0.502	0.809
trust 4	0.748	0.740	0.701	0.618	0.444	0.852
trust 5	0.692	0.707	0.606	0.532	0.319	0.829
trust 1	0.501	0.472	0.592	0.628	0.583	0.651

5. Discussion

In this study, we underscore the importance of an extensive theoretical model such as UTAUT in steering both research and practical applications within the VR technology domain. By shedding light on crucial factors that drive user acceptance, we enhance the overall comprehension of the intricate interplay between human behavior and novel technological developments. This, in turn, facilitates the successful incorporation of VR into diverse fields such as education, healthcare, and entertainment.

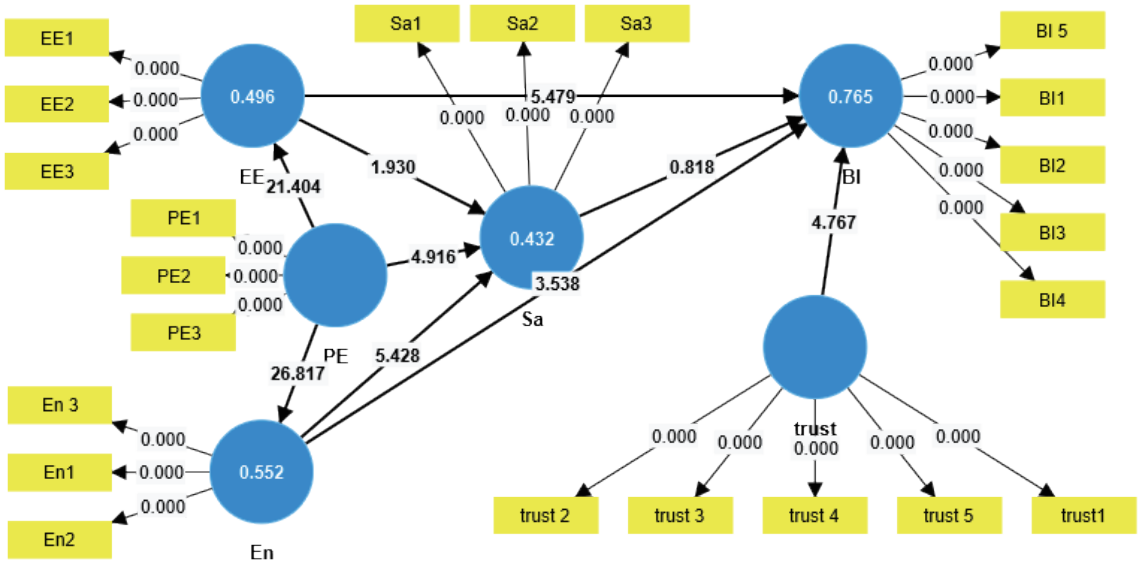

Fig. 4. (Color online) Path diagram for model.

Table 5
Path coefficients.

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	*T* statistics (|O/STDEV|)	*P* values
EE → BI	0.370	0.367	0.068	5.479	0.000
EE → Sa	−0.168	−0.166	0.087	1.930	0.054
En → BI	0.240	0.237	0.068	3.538	0.000
En → Sa	0.463	0.462	0.085	5.428	0.000
PE → EE	0.704	0.705	0.033	21.404	0.000
PE → En	0.743	0.744	0.028	26.817	0.000
PE → Sa	0.377	0.379	0.077	4.916	0.000
Sa → BI	−0.035	−0.033	0.043	0.818	0.414
trust → BI	0.343	0.348	0.072	4.767	0.000

6. Conclusions

6.1 Application and prospects of UTAUT model in the adoption of VR technology (Fig. 4 and Table 5)

The results indicate that students using VR applications exhibit higher levels of engagement, absorption, and immersion in the learning experience than those using only mobile applications.[26] This unique research endeavor seeks to investigate the utilization of the Technology Acceptance Model (UTAUT) in the adoption of VR technology while scrutinizing its potential implications for the advancement of VR technology. By delving into the four primary components of the UTAUT model, namely, perceived usefulness, perceived ease of use,

subjective norms, and perceived behavioral control, we have obtained a profound comprehension of the pivotal factors influencing the adoption of VR technology. Additionally, we have put forth recommendations for future development and obtained valuable insights from this exploration.

We initiated the study by conducting an extensive literature review, amalgamating a multitude of research findings, and validating the relevance of the UTAUT model in the context of VR technology adoption research. The outcomes of our research underscore that users' perceived usefulness of VR technology stands as a significant determinant affecting its adoption. When users perceive practical benefits associated with VR technology, such as enhanced work efficiency, improved learning experiences, or enhanced medical treatments, they exhibit a greater propensity to actively embrace this technology.

Furthermore, the perceived ease of use has also been established as a critical factor in determining users' willingness to adopt VR technology. Users' assessments of the ease of acquiring and using VR technology substantially influence their adoption decisions. Additionally, the impact of subjective norms within the social environment on the adoption of VR technology cannot be underestimated. The degree to which users are influenced by the opinions and expectations of others plays a pivotal role in shaping their inclination to explore VR technology.

Finally, perceived behavioral control also affects users' adoption behavior to a certain extent. This finding underscores the relevance of the chosen platform in virtual-assisted language learning and emphasizes the importance of good educational materials for second language vocabulary acquisition.[27] Users' ability and confidence in their own abilities will influence their ability to overcome possible obstacles and adopt new technologies.

However, we also identified some challenges and unresolved issues. As VR technology continues to develop, many users may still have misunderstandings or doubts about the concepts and applications of VR, which may affect their acceptance of the technology. In addition, the hardware and software requirements of VR technology may cause difficulties for some users, further affecting their willingness to adopt it. When promoting the popularization and application of VR technology, we need to adopt corresponding strategies to address these challenges, provide more education and training, and improve the ease of use of the technology.

Regarding future development, we believe that VR technology will continue to have a profound impact in various fields. With the advancement and continuous innovation of technology, we can foresee that VR will play a significant role in education, medical care, design, entertainment, and other fields. Simultaneously, it is imperative to persist in investigating and delving into the practical implications of VR technology across diverse scenarios. We must also strive to devise improved strategies aimed at fostering users' willingness to embrace and engage with VR technology.

In short, this study combines the UTAUT model and VR technology, and provides important guidance and inspiration for us to better understand and apply VR technology by analyzing its influencing factors and future prospects. We expect this research to contribute to the promotion and development of VR technology and promote its widespread application and impact on society.

6.2 Limitations and suggestions

Drawing upon the findings of this research, the following suggestions are presented regarding the integration of UTAUT and VR technology:

- **Enhance perceived utility and user-friendliness**: In the promotion of VR technology, it is essential to underscore its tangible advantages and user-friendly attributes. Developers should prioritize enhancing the technology's functionality and performance, ensuring that users can derive direct benefits and enjoy a seamless user experience.
- **Strengthen subjective norms**: Create a supportive social environment to encourage users to try and adopt VR technology. Hosting relevant events, sharing success stories, and building communities and discussion platforms can increase the positive impact of subjective norms on technology adoption.
- **Enhance perceived behavioral control**: Detailed user guides, training resources, and technical support are provided to help users overcome possible obstacles. At the same time, developers can consider providing more personalized options so that users can better control the use of technology.
- **Continuous research and innovation**: VR technology is an evolving field that demands ongoing research and inventive advancements. Subsequent investigations can delve into additional facets of VR, including the interplay between VR and the physical world and the perceived authenticity of the technology.
- **Education and outreach**: More educational and promotional activities should be conducted to help the public better understand the application value and potential of VR technology. This helps reduce doubts and misunderstandings about the technology and increases users' willingness to adopt it.

To conclude, the UTAUT model serves as a crucial framework enabling us to grasp and facilitate the adoption of VR technology. With ongoing research and practical applications, we hold a strong belief that VR technology will usher in further innovations and transformative developments across various domains.

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