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ChatGPT in higher education: factors influencing ChatGPT user satisfaction and continued use intention

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Artificial intelligence (AI) chatbots, represented by ChatGPT, have shown significant improvement in natural learning and problem analysis and solving, which could trigger a profound change in the education sector and have a far-reaching impact on educational practices. This study aimed to gain insights into the various impacts on users' experience when using the AI tool ChatGPT in higher education. The study analyzed questionnaire data from 328 college students who used ChatGPT. Employing structural equation modeling, this study examined the technology acceptance model in the higher educational setting to identify factors influencing continued use of ChatGPT. The results show that ChatGPT's compatibility positively affected users' perceived ease of use and that efficiency positively affected perceived usefulness. Furthermore, perceived ease of use and perceived usefulness were identified as core factors affecting users' satisfaction and continued use intentions, with user satisfaction showing a significant positive effect on continued use intention. The findings not only provide new perspectives on human-computer interaction theory in higher education but also further refine the functions of current smart devices. This study will help to promote the continued progress and improvement of educational technology, while also deepening understanding of the relationship between attitude and behavior.

KEYWORDS

ChatGPT, technology acceptance model, satisfaction, continued use intention, higher education

1 Introduction

Alongside the continuous advancement of artificial intelligence (AI), chatbot technology has penetrated all aspects of people's daily lives and is widely used in several industries. The success of AI chatbots in social networking environments has demonstrated their indispensable role in the forthcoming information society. In recent years, with the continuous expansion of chatbot functionality and advances in language processing technology, advanced AI models such as ChatGPT have been developed. Scholars have generally interpreted the birth of ChatGPT as a harbinger of a new era. In the context of the current era, it has been noted that AI is gradually shifting from an algorithm-based intelligence model to a language-based one, proving its great potential to reach the human intelligence standard (Zhou et al., 2023).

ChatGPT was developed by the commercial enterprise OpenAI and is an innovative AI chatbot built on large-scale language models (Schulman et al., 2022; Zou and Huang, 2023). It employs popular natural language processing (NLP) technology, big data analytics, speech recognition technology, etc., and has rich and powerful conversational features. Upon its launch, ChatGPT achieved rapid user growth in just two months, becoming one of the fastest-growing consumer apps and one of the most effective chatbot platforms in history. It uses NLP technology to build the complex information needed during user interactions and provide related services. This system is an autonomous machine learning platform that is trained on deep learning neural networks. By training on large amounts of textual data, it is able to generate advanced writing that looks intelligent on the surface (Zhou et al., 2023). The main difference between ChatGPT and other models that have been introduced is that it can generate responses that are similar to human user input and can understand and answer users' questions in a natural and conversational way. Additionally, it can be personalized for specific domains or applications, demonstrating a model that responds to user input in a conversational context. Furthermore, ChatGPT can provide detailed answers to complex questions, giving users a way to get the information they need quickly and efficiently. Over the past few years, the use of chatbots has shifted away from the early days of "bots" to "intelligent people." ChatGPT's proficiency is largely due to its sizable corpus of data, which allows it to understand subtle differences in language usage and context and respond intelligently to a wide range of queries, including everyday conversations and technical and professional topics (Lund and Wang, 2023; Orrù et al., 2023). Due to its unique features, ChatGPT has been embraced by a large number of software developers, creative writers, and academic researchers, who utilize it to develop computer software, applications, texts, academic papers, and lyrics (Dave et al., 2023; Dwivedi et al., 2023).

ChatGPT is a revolutionary AI conversational bot that has dramatically changed the way natural learning is practiced, as well as the ability to analyze and solve problems (Dwivedi et al., 2023). Therefore, ChatGPT is seen as a practical tool that provides users with real-time feedback and answers to questions and helps them solve their daily problems, thus reducing the burden on users and allowing them to focus on solving higher-level problems. Currently, many researchers are working to develop dialog systems with better interactive experiences. ChatGPT has also generated widespread attention and strong interest in the global educational community (Duong et al., 2023; Tlili et al., 2023). As a catalyst for educational reform, AI tools will optimize learning styles and improve the overall quality of education through more efficient access to knowledge (Ma and Huo, 2023). The integration of ChatGPT into the education sector has generated a great deal of interest and enthusiasm. Nowadays, it has transformed into an innovative and inclusive teaching, learning, and assessment tool that is in line with the direction of modern knowledge change. ChatGPT can be used as a tool to reassess one's approach to learning and enhance learning outcomes. In the higher education field, in particular, ChatGPT shows great development potential, which may trigger profound change in education and have a far-reaching impact on higher educational practices.

Current research focuses on the possible future advantages and disadvantages of ChatGPT in education. For example, although ChatGPT can provide rich teaching resources, enhance student engagement and interactivity, and provide a personalized learning experience, it can also lead to a series of problems, such as potential errors in output, the potential risk of misuse, and problems related to privacy protection. Although there has been increasing academic interest in the use of ChatGPT in higher education, little research has been conducted on the causal variables of college students who use ChatGPT in their work and studies. Therefore, this study aimed to fill the existing research gap and identify the key factors that constitute the main reasons college students consistently choose to use ChatGPT.

Based on diffusion of innovation theory, use and gratification theory, and the technology acceptance model, this study proposes a new research model to explain college students' satisfaction with and intention to continue using ChatGPT. The model asserts that ChatGPT possesses compatibility and efficiency qualities that stimulate users' perceived ease of use and usefulness, thus contributing to college students' satisfaction and continued use intentions. To validate the proposed model, a questionnaire was administered via Prolific.¹ A total of 328 valid responses were collected, providing data to validate the research hypotheses.

This study makes several valuable contributions. Firstly, the study is unique in that it specifically highlights the fact that the recent language model known as ChatGPT has not yet received extensive scholarly attention in the field of higher education. Given that there is relatively little extant research on ChatGPT, especially studies exploring its application and acceptance in the higher educational domain, this study focuses on its innovative nature. Moreover, this study focuses on AI's service to the higher educational field and deepens the literature on human-computer interaction in higher education to promote the continuous progress and improvement of educational technology. ChatGPT has made a valuable contribution to research on technological acceptance and application, while simultaneously providing new insight specifically into the acceptance and application of AI-based language modeling, thereby further expanding the scope of AI research. Secondly, the present study delved into the major concerns of college students who use ChatGPT in terms of human-computer interaction patterns and styles and concluded that their cognitive and affective attitudes are key determinants of their willingness to use ChatGPT. The proposed research model provides an all-encompassing analytical framework for examining the various factors that influence technology acceptance and adoption. Finally, the study incorporated diffusion of innovation theory, use and gratification theory, and the technology acceptance model in relation to ChatGPT, and this study proposes a series of variables that aim to positively enhance user experience and people's willingness to use. This will help to further broaden the technology acceptance model application areas in educational practice, thus promoting human-computer interaction in higher education. Moreover, this study provides new ideas for researchers in related fields to explore ways to improve the quality of the learning process from the perspective of interaction design toward improving learning outcomes. This

¹ <https://app.prolific.com/>

study's results will deepen understanding of the application and use of ChatGPT in higher education and support efficient use of this technology in education.

To provide a comprehensive understanding, the paper is organized as follows: Section 2 encompasses literature reviews and hypothesis development; Section 3 elucidates the method; Section 4 introduces hypothesis validation via structural equation modeling; Section 5 outlines the discussion; Section 6 describes the conclusion.

2 Literature review and hypothesis development

2.1 ChatGPT in education

ChatGPT is an NLP model developed by the commercial company OpenAI. In short, it is an innovative AI chatbot built on a large-scale language model (Schulman et al., 2022). The system was developed on the basis of generative pre-trained transformer architecture with independent machine learning capabilities, and it was originally designed to meet the specific needs of language generation tasks. ChatGPT differs from other AI models for text-to-image generation in that it represents an innovative AI technology. It employs a computational model that is independent of the human brain to deal with natural language understanding problems. This technology is capable of continuously interacting with users, reacting to user inputs, and providing users with conversational feedback. The system helps users understand and interpret discussion topics by continuously outputting information and delivering results. Its main purpose is to create new ideas or content and elaborate them in real-time dialog. Such dialog improves the understanding and use of NLP, as well as the human intelligence level. One of ChatGPT's distinguishing features is its ability to maintain a consistent conversational style by assuming various roles or identities throughout an interaction, which allows for more realistic and natural conversations rather than irrelevant or unrelated responses. To facilitate this, ChatGPT is trained on a large dataset of conversational text that includes chat logs and various forum and social media posts; it therefore has the ability to generate prompts and questions that resemble human responses (Qadir, 2023). As of ChatGPT's ability to provide users with instant and personalized service, a variety of industries have begun to utilize the tool in their work and studies. ChatGPT has been identified as a valuable asset in a variety of industries including but not limited to poetry writing, academic research and writing, business communications, software development, and testing activities (Tung, 2023).

With global integration and rapid technological advances, the use of AI and NLP technologies in higher education has grown by leaps and bounds, and the way languages are learned, taught, and assessed has undergone a corresponding transformation. The use of educational chatbots is increasing as they offer a cost-effective and efficient way to engage students and provide a personalized learning experience (Benotti et al., 2017; Albayati, 2024; Polyoportis, 2024). As a chatbot powered by generative AI, ChatGPT is rapidly evolving and has the potential to spark an

education revolution. To better meet society's needs, the higher education industry has begun to use a variety of tools to increase classroom efficiency and improve teaching and learning. One of the most important aspects is the use of machines to assist in teaching and learning, and AI is among the most commonly utilized means. Numerous scholars have begun to research the practical applications of ChatGPT in various education-related fields; topics include the practical use of ChatGPT in education, research, and various professional activities (Brown et al., 2020; Emenike and Emenike, 2023) and ChatGPT-aided language learning (Kasneci et al., 2023). In education, AI is defined as a computational system capable of performing manual processes (Popenici and Kerr, 2017). ChatGPT and other NLP models play an integral role in higher education.

2.2 ChatGPT's compatibility

Diffusion of innovation theory is considered a landmark theory. It has five main characteristics: relative advantage, compatibility, trialability, observability, and complexity (Rogers and Williams, 1983). Diffusion of innovation theory details how, over time, an idea or product gains strong traction or spreads through a particular demographic or social structure. This is often viewed as a phenomenon known as innovation. To achieve this, strategies that differ from what has been done before are implemented. People may not publicize their ideas if they feel that innovation can be achieved in other ways. This approach to innovation does not show a uniform pattern across all participants; there may be differences depending on the duration of acceptance of an innovation as well as adopters' unique characteristics (Rogers and Williams, 1983).

The compatibility component of diffusion of innovation theory is defined as the degree to which people perceive innovation to be compatible with the way they think, behave, and live (Rogers and Williams, 1983). Compatibility constitutes a key element of innovation that directly affects the ability to meet users' needs. ChatGPT's compatibility performance is based on its capabilities in language comprehension, dialog generation, and personalized replies, and continuous improvement is required to better meet users' needs. ChatGPT's compatibility features have made it a relatively versatile and flexible NLP model. Users can typically customize and fine-tune the chatbot according to their needs, and the tool can also be applied to many different scenarios and tasks to meet specific business needs. In previous research, higher education student users identified compatibility as an important factor affecting ChatGPT use intentions (Raman et al., 2023).

Research has shown that a high degree of compatibility leads to a greater propensity to use a given system, as well as to a superior user experience since users exert less effort; it has been found that this may influence actual application through behavioral intent (Wu and Wang, 2005). Moreover, it is known that perceived ease of use depends greatly on compatibility (Akturan and Tezcan, 2012). ChatGPT's compatibility features allow it to adapt to continuous changes in user needs and different conversational environments, user habits, and preferences. Based on user feedback and habits, ChatGPT can provide a personalized experience that is user-friendly and highly compatible with users' habits. Additionally, ChatGPT is highly flexible and versatile to meet the specific needs

of a variety of users, such as those of different ages, cultural backgrounds, or areas of specialization; this further enhances its ease of use in the user community. Therefore, we formulated the following hypothesis:

H1: ChatGPT's compatibility positively impacts ease of use.

2.3 ChatGPT's efficiency

In the context of human–computer interaction, use and gratification theory provides a more in-depth view to help understand the reasons for and the ways in which users choose to interface with AI as well as how does AI fulfill these unique demands. Thus, Uses and Gratifications Theory is considered a theoretical framework that aims to research why users choose to use ChatGPT the way they do as well as how it meets those user demands (Baek and Kim, 2023). The researchers applied the Uses and Gratifications theory and the literature on human–computer interaction in the larger ChatGPT environment and proposed five top user motivations when utilizing AI agents: information seeking, task efficiency, personalization, social interaction, and playfulness (Baek and Kim, 2023).

Efficiency, which is a use driver according to use and gratification theory, describes the extent to which a system helps individuals accomplish their duties or goals efficiently and effectively (Park, 2010). With the rapid development of technology and the continuous improvement of information dissemination tools, more people have begun to pay attention to work efficiency and strive to improve their work performance. To perform specific tasks more efficiently, people are likely to choose to use ChatGPT. Considering that it features fast responses and can handle multiple conversations at once, demonstrating its ability to process a large amount of information in a very short period of time (Else, 2023). Hence, ChatGPT can enhance productivity through process automation. It is capable of achieving collaborative goals by providing practical information and personalized support in real time to effectively save users time and money and improve production quality.

Efficiency is seen as a key determinant of the relationship between perceived usefulness and technology acceptance, and this contributes to a better understanding of user acceptance of new interactive tools in learning and practice settings (Estriegana et al., 2019). It has been established that a technology's usefulness directly determines task execution effectiveness, that is, whether users accomplish their tasks efficiently and effectively (MacDorman et al., 2011). ChatGPT demonstrates efficiency not only through the provision of accurate information and the precise performance of first-level tasks but also through its high degree of automation and task completion. Its ability to automate specific tasks saves users a significant amount of time and effort, making it a highly effective and convenient tool that can increase users' perceived usefulness. Therefore, we formulated the following hypothesis:

H2: ChatGPT's efficiency positively affects perceived usefulness.

2.4 Perceived ease of use and perceived usefulness

Davis (1989) designed the technology acceptance model based on the theory of reasoned action (Fishbein and Ajzen, 1977). The model's main purpose is to parse and predict users' perspectives and intentions to use emerging information technologies, with the core objective of identifying influencing factors related to information system acceptance (Davis, 1989). To better predict and explain users' novel information technology acceptance mechanisms, it is first necessary to gain an in-depth understanding of why users accept or reject technologies, so that users' behavioral habits can be predicted and interpreted more accurately. In this regard, the technology acceptance model, as a simplified version of the theory of reasoned action, focuses on explaining technology acceptance-related behaviors and exploring their influencing factors; many researchers have also used it to study human–machine interactions (Del Giudice et al., 2023). In this view, a person's motivation to and act of embracing a new technology are based on personal benefits that are largely dependent on perceived ease of use and usefulness (Davis, 1989). The purpose of this study was to understand the acceptance and satisfaction of college students when using ChatGPT as an aid to accomplish academic or professional tasks, for example, ChatGPT that is accepted and utilized by students will be more conducive to their academic achievement. Utilizing the technology acceptance model helps to understand how the structure of technology acceptance model relates to students' acceptance of ChatGPT as an assistive tool. If students find ChatGPT easy to use and find it useful, it may positively influence their satisfaction and willingness to continue using it.

According to the technology acceptance model, perceived ease of use is the level at which a person perceives that a technology or information system will be relatively simple and easy to operate, whereas perceived usefulness is the extent to which an individual perceives the performance of a specific set of systems to be effectively improved by using it (Davis, 1989). These two critical elements have been shown to play a vital role not only in the initial acceptance of a technology but also in its continued use. ChatGPT's official statement makes it clear that this is the first time such an efficient tool has been made available to a wide range of users through a free, user-friendly web interface (Roose, 2022). Specifically, extant research has established that a ChatGPT-type system is easy for users in an educational context to learn how to operate (Strzelecki, 2023; Saif et al., 2024). Therefore, ChatGPT attracts people because it is easy to use and provides useful information, continuously creating value for users.

The technology acceptance model is an important measure of acceptance of and satisfaction with ChatGPT among users with different interests (Mathieson, 1991; Baytak, 2023). Empirical research has established the roles of perceived ease of use and usefulness in user satisfaction (Kashive et al., 2020). Additionally, when users believe that they can quickly and easily master new technologies and are convinced that a technology is practical, they usually show a strong technological adoption intention (Kao and Huang, 2023). Therefore, if users believe that ChatGPT is not only easy to operate but also powerful and capable of significantly improving the overall user experience while conserving users' time and effort, it can be expected that users will express a higher level

of satisfaction with ChatGPT and that their continued use intention will increase such that they ultimately become loyal ChatGPT users. Therefore, we formulated the following hypotheses:

H3: ChatGPT's perceived ease of use positively affects satisfaction with ChatGPT.

H4: ChatGPT's perceived ease of use positively affects continued use intention.

H5: ChatGPT's perceived usefulness positively affects satisfaction with ChatGPT.

H6: ChatGPT's perceived usefulness positively affects continued use intention.

2.5 Satisfaction with ChatGPT and continued use intention

User satisfaction is a common measure of a system's success, but this core subjective evaluation method is based on a combination of the user's overall system usage experience and its impacts (Urbach and Müller, 2012). Satisfaction is a cumulative feeling resulting from multiple interactions with a system. In the field of technology acceptance models and user behavior research, satisfaction plays a crucial role and significantly influences users' behavioral intentions, which represent users' expected future behavior toward a system (Ashfaq et al., 2020). Multiple studies have pointed to the significant impact of user satisfaction on building and maintaining a long-term loyal user base and have highlighted that it is a key determinant of ongoing usage behavior (Nascimento et al., 2018). Hence, a user's level of satisfaction with ChatGPT will directly determine their willingness to continue using it. For instance, if a user is dissatisfied with a particular mobile application, they may stop using it. However, if users are satisfied with ChatGPT, they will be more likely to use it consistently and continue using the tool in the future. Therefore, we formulated the following hypothesis:

H7: Satisfaction with ChatGPT positively affects continued use intention.

3 Materials and methods

3.1 Data collection and sample

To validate the research model (see Figure 1) and hypotheses, a questionnaire survey comprising measurement items for the constructs specified in the proposed research model was administered via Prolific² to a research population primarily of

college students within the United States. Considering the practical needs of ethical research, all survey respondents were informed of the research objectives and assured that their answers would be kept strictly confidential and used for academic purposes only. A total of 328 valid questionnaires were collected. Respondents comprised 198 males (60.37%) and 130 females (39.63%). The majority had a college or university degree (80.19%). Their predominant ChatGPT usage frequency was two to four times per week (31.4%), followed by once per week (15.5%). Respondents' demographic characteristics are shown in Table 1.

3.2 Instrument development

The survey comprised 19 items developed with reference to the existing literature and appropriately adapted to meet the study's contextual needs. Three items on compatibility were adapted from Moore and Benbasat (1991), and four items on efficiency were adapted from Choi and Drumwright (2021) and Baek and Kim (2023). Six items on perceived ease of use and perceived usefulness were adapted from Davis (1989) and Boubker (2024). Satisfaction was measured by adapting three items from Mohammadi (2015) and Boubker (2024), respectively. Three items on continued use intention were adapted from Baek and Kim (2023). Items were rated on a 5-point Likert scale ranging from 1 = *Strongly disagree* to 5 = *Strongly agree*. Table 2 summarizes the measurement items of the study. The scales are shown in Table 3.

3.3 Reliability and validity analysis

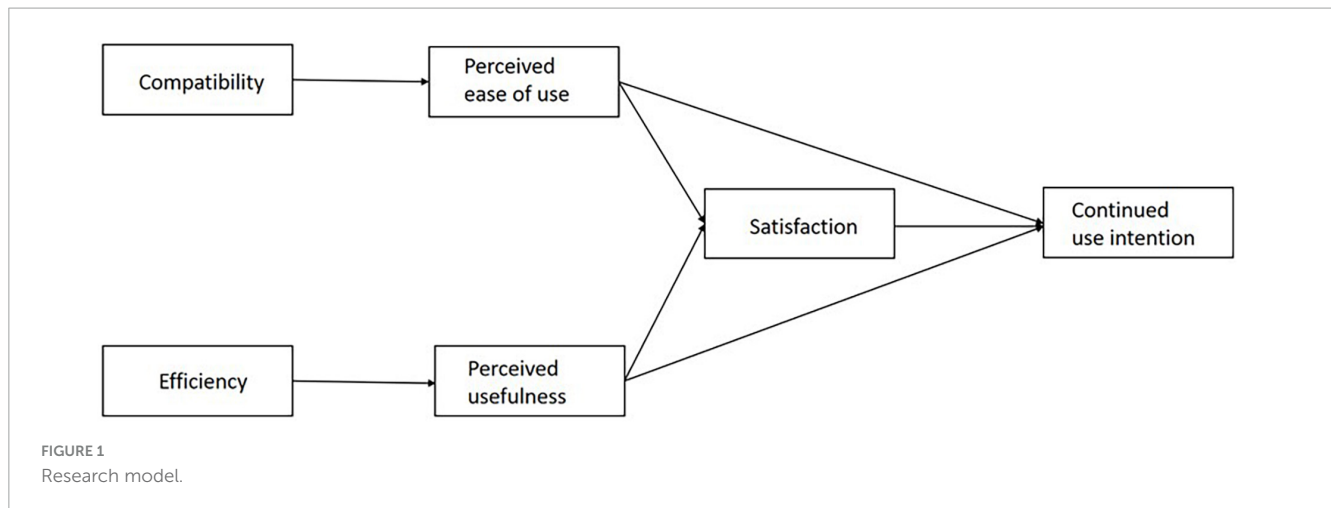
To assess scale reliability, Cronbach's α coefficient was calculated using SPSS 28.0. According to the test results shown in Table 3, Cronbach's α coefficients of compatibility, efficiency, perceived ease of use, perceived usefulness, satisfaction, and continued use intention exceeded 0.8, indicating satisfactory scale reliability.

Confirmatory factor analysis was used to test the above indicators' convergence and validity. According to the results shown in Table 3, all variables' standardized factor loadings (SFL) exceeded 0.7, composite reliability (CR) exceeded 0.8, and average variance extracted (AVE) exceeded 0.6, indicating reliable measurements. According to the results shown in Table 4, the square root of the AVE for each variable was greater than the correlation coefficient between the variables, and the data showed good discriminant validity, indicating high questionnaire validity.

3.4 Analysis of model fit

According to the results shown in Table 5: $\chi^2 = 471.514$, $df = 137$, $\chi^2/df = 3.442$, $p < 0.001$, goodness of fit index (GFI) = 0.862, adjusted goodness of fit index (AGFI) = 0.809, normed fit index (NFI) = 0.916, comparative fit index (CFI) = 0.938, Tucker-Lewis index (TLI) = 0.923, root mean square error of approximation (RMSEA) = 0.086, incremental fit index (IFI) = 0.939, standardized root means square residual (SRMR) = 0.049. The above data indicate alignment of the

² <https://app.prolific.com/>



measurement model's fitted metrics with the desired values, suggesting that the hypothesized model and the survey data fit well.

4 Hypothesis validation via structural equation modeling

Table 6 shows the structural modeling test results. Significant path coefficients were found between compatibility and perceived ease of use ($\beta = 0.606, p < 0.001$), efficiency and perceived usefulness ($\beta = 0.951, p < 0.001$), perceived ease of use and satisfaction ($\beta = 0.236, p < 0.001$), perceived ease of use and continued use intention ($\beta = 0.138, p = 0.003$), perceived usefulness and satisfaction ($\beta = 0.732, p < 0.001$), perceived usefulness and continued use intention ($\beta = 0.628, p < 0.001$), and satisfaction and continued use intention ($\beta = 0.195, p = 0.028$). These results provide empirical support for H1–H7.

5 Discussion

5.1 General discussion

ChatGPT, a language model driven by AI technology, has garnered academic attention. It brings many profound benefits, such as creating academic content and improving its accessibility, enhancing team collaboration, and conducting relevant assessments (Bin-Nashwan et al., 2023). Therefore, emerging AI technologies like ChatGPT have been recognized for their tremendous potential to transform the education industry in an unprecedented way. This study delved into whether ChatGPT's unique nature can enhance user acceptance and individuals' propensity to use the application in higher education. The findings not only provide fresh theoretical support for chatbot research but also have the potential to become a central element in enhancing learning effectiveness and promoting higher educational development.

This study utilized a questionnaire survey designed to gain insight into users' attitudes toward and opinions about using ChatGPT in their daily lives. From a data processing

TABLE 1 Subjects' demographics (N = 328).

Demographics	Classification	Frequency	Percentage (%)
Gender	Male	198	60.37
	Female	130	39.63
	Total	328	100.00
	Some college or vocational school	126	38.42
	Bachelor's degree	137	41.77
	Master's degree	54	16.46
	Doctoral degree	11	3.35
	Total	328	100.00
Usage frequency	Very infrequently	36	10.98
	Once a month	47	14.33
	Once every other week	24	7.32
	Once a week	51	15.55
	2–4 times a week	103	31.40
	Once a day	21	6.40
	Several times a day	46	14.02
	Total	328	100.00

perspective, ChatGPT is considered to be highly compatible, efficient, easy to use, and useful due to its excellent interactive performance. These unique characteristics not only enhance college students' satisfaction with this technology but also inspire a strong desire for continued use of the application. The study results reflect all the pre-determined drivers of college students' ChatGPT usage. Most survey respondents reported believing that ChatGPT provides them with rich, relevant, and all-encompassing information that helps them accomplish their academic and professional tasks. Therefore, ChatGPT is seen as a reliable AI alternative with significantly superior performance compared to other search engines (Menon and Shilpa, 2023).

TABLE 2 Measurement items.

Construct	Items	References
Compatibility	Using ChatGPT is compatible with all aspects of my learning.	Moore and Benbasat, 1991
	I think that using ChatGPT fits well with the way I like to learn.	
	Using ChatGPT fits into my learning style.	
Efficiency	I use ChatGPT because it saves me time when I'm completing my tasks.	Choi and Drumwright, 2021; Baek and Kim, 2023
	I use ChatGPT because it makes my tasks easier.	
	I use ChatGPT because it improves my quality output.	
	I use ChatGPT because it is useful for multitasking.	
Perceived ease of use	I find ChatGPT easy to use.	Davis, 1989; Boubker, 2024
	My interaction with ChatGPT is clear and understandable.	
	I find it easy to get ChatGPT to do what I want it to do.	
Perceived usefulness	Using ChatGPT will improve my learning.	Davis, 1989; Boubker, 2024
	Using ChatGPT will enhance my effectiveness.	
	I find ChatGPT to be a useful tool in my learning.	
Satisfaction	I am pleased enough with ChatGPT.	Mohammadi, 2015; Boubker, 2024
	ChatGPT satisfies my educational needs.	
	I am satisfied with ChatGPT's performance.	
Continued use intention	I plan to keep using ChatGPT.	Baek and Kim, 2023
	I want to continue using ChatGPT.	
	I intend to recommend ChatGPT to my friends.	

TABLE 3 Reliability and validity analysis.

Construct	Items	SFL	CR	AVE	α
Compatibility	Using ChatGPT is compatible with all aspects of my learning.	0.776	0.912	0.777	0.907
	I think that using ChatGPT fits well with the way I like to learn.	0.949			
	Using ChatGPT fits into my learning style.	0.910			
Efficiency	I use ChatGPT because it saves me time when I'm completing my tasks.	0.820	0.870	0.627	0.865
	I use ChatGPT because it makes my tasks easier.	0.818			
	I use ChatGPT because it improves my quality output.	0.813			
	I use ChatGPT because it is useful for multitasking.	0.712			
Perceived ease of use	I find ChatGPT easy to use.	0.771	0.853	0.660	0.842
	My interaction with ChatGPT is clear and understandable.	0.881			
	I find it easy to get ChatGPT to do what I want it to do.	0.779			
Perceived usefulness	Using ChatGPT will improve my learning.	0.841	0.876	0.703	0.875
	Using ChatGPT will enhance my effectiveness.	0.815			
	I find ChatGPT to be a useful tool in my learning.	0.857			
Satisfaction	I am pleased enough with ChatGPT.	0.876	0.891	0.732	0.886
	ChatGPT satisfies my educational needs.	0.842			
	I am satisfied with ChatGPT's performance.	0.849			
Continued use intention	I plan to keep using ChatGPT.	0.903	0.921	0.796	0.909
	I want to continue using ChatGPT.	0.935			
	I intend to recommend ChatGPT to my friends.	0.835			

Firstly, this study has shown that compatibility positively impacts perceived ease of use and that efficiency positively impacts perceived usefulness. The two core elements of ChatGPT's innovation are compatibility and efficiency, which directly

determine its perceived performance. Therefore, ChatGPT needs to fulfill users' practical needs as much as possible to secure a reputation for being easy to use and useful within its user community. Secondly, the empirical research results have also

TABLE 4 Discriminant validity analysis results.

	Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)
(1) Compatibility	3.826	0.886	0.882					
(2) Efficiency	3.986	0.804	0.700	0.792				
(3) Perceived ease of use	4.189	0.683	0.532	0.54	0.812			
(4) Perceived usefulness	3.980	0.828	0.789	0.774	0.576	0.838		
(5) Satisfaction	2.381	0.468	0.720	0.714	0.604	0.763	0.856	
(6) Continued use intention	4.173	0.856	0.731	0.721	0.584	0.803	0.761	0.892

The diagonal numbers are AVE square root values.

confirmed the two key components of theory of reasoned action, with the data showing significant path coefficients and indicating that ease of use and usefulness are key factors that may influence users' willingness to use ChatGPT. Users' opinions about ChatGPT's ease of use have been shown to be a key factor influencing satisfaction. This suggests that when users find ChatGPT easy to operate, their satisfaction will increase accordingly. Earlier research revealed similar findings regarding the impact of perceived ease of use does positively contribute to satisfaction (Kashive et al., 2020). The study results have also shown that ChatGPT's perceived usefulness significantly affects satisfaction with using the tool. Specifically, positive perceptions of ChatGPT's usefulness may motivate users to use the tool more frequently and develop higher levels of satisfaction with it. This discovery is consistent with prior research that users are more likely in adopting technology and are comfortable with it when they find it valuable (Al-Fraihat et al., 2020). Thus, ChatGPT, as an easy-to-use and practical technological tool, incentivizes technological adoption and acceptance by providing users with innovative problem-solving strategies. Ultimately, a favorable and important effect of satisfaction on continued use intention was found. Moreover, satisfaction has been identified as a key determinant of continued use intention. Additionally, it has been shown that users' satisfaction positively predicts their continued use intentions, and this effect increases with increased satisfaction (Chen et al., 2020). Hence, users who view ChatGPT positively and are satisfied with it are more likely to continue using the tool in the future.

By delegating these tasks to ChatGPT when dealing with everyday academic issues, students can focus more on completing advanced tasks. Some educators have found that ChatGPT's ability to provide immediate feedback and support has a catalytic effect on student engagement and motivation, noting that students who receive timely and accurate answers to their questions are more likely to be supportive and confident in their learning, which in turn leads to better academic performance (Limna et al., 2023). However, some scholars have also expressed concern about the negative effects of students' over-reliance on ChatGPT in the learning process, particularly their ability to understand and answer complex questions. Scholars believe that the information that students are prone to produce in the process of extracting new knowledge can also have some negative impact on their critical thinking and problem-solving skills. Since ChatGPT simplifies the process of acquiring information, this may lead to a lazy attitude toward learning and reduce students' interest in conducting investigations to arrive at personal conclusions or solutions (Kasneci et al., 2023).

TABLE 5 Model fit index.

Index	Criteria	Value	References
GFI	> 0.85	0.862	Jöreskog, 1969; Sarmiento and Costa, 2019
RMSEA	< 0.10	0.086	
CFI	> 0.90	0.938	
NFI	> 0.90	0.916	
TLI	> 0.90	0.923	
SRMR	< 0.10	0.049	

GFI, goodness-of-fit index; NFI, normalized fit index; CFI, comparative fit index; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual.

5.2 Research implications

This study makes substantial theoretical contributions. Firstly, the study analyzes the theoretical underpinnings of the acceptance and adoption of ChatGPT in depth in several ways, innovatively integrating diffusion of innovation theory, use and gratification theory, and technology acceptance models into a concise model of ChatGPT. Given the key elements involved in the adoption of this innovative tool, a series of variables designed to enhance user experience and usage intention have been proposed and analyzed in depth. Regarding the use of AI chatbots such as ChatGPT as an educational innovation (Chen, 2010; Ratten and Jones, 2023), the findings provide useful evidence for the link between ChatGPT usage factors and relevant theories. Furthermore, the findings provide valuable insights into how human-machine interaction needs can be met through generative AI, thereby greatly enriching the existing literature. Secondly, building on previous work on the necessary conditions for establishing continued use intentions toward AI technologies (Ashfaq et al., 2020; Jo, 2023), this study has provided an in-depth analysis of the key ChatGPT features that affect user satisfaction and usage intention, such as compatibility, efficiency, perceived usefulness, and perceived ease of use, in a context of modern users' prevalent interaction patterns and styles. Moreover, the study has filled the research gap regarding college students who use ChatGPT in higher educational settings, and it provides valuable insights into the cognitive and affective attitudes of AI chatbots, as represented by ChatGPT, in the higher education domain. Finally, scholarly exploration of the interactive characteristics of ChatGPT will help enhance social interaction. In-depth research on the use of ChatGPT in higher education not only broadens the theoretical basis of educational technology but also

TABLE 6 Results of structural modeling testing of the hypotheses.

	Path	ρ	β	Results
H1	Compatibility → Perceived ease of use	0.000	0.606	Supported
H2	Efficiency → Perceived usefulness	0.000	0.951	Supported
H3	Perceived ease of use → Satisfaction	0.000	0.236	Supported
H4	Perceived ease of use → Continued use intention	0.003	0.138	Supported
H5	Perceived usefulness → Satisfaction	0.000	0.732	Supported
H6	Perceived usefulness → Continued use intention	0.000	0.628	Supported
H7	Satisfaction → Continued use intention	0.028	0.195	Supported

promotes the development of personalized learning, technology-integrated teaching, and the integration of educational technology, thus providing a solid theoretical foundation and directional guidance for the wide application and further development of educational technology in the future.

This study also has long-term implications for the practical application of AI chatbots, as symbolized by ChatGPT. Firstly, the results have demonstrated that ChatGPT has high compatibility, efficiency, and output quality, features that increase user awareness of the tool's utility and ease of use and stimulate great interest in using the tool, ultimately leading to increased satisfaction. For specialists working on the development and supply of AI technologies, it is vital to ensure that users have a deep understanding of the benefits and possible usage scenarios of the technologies on which applications are based. In other words, when developing new AI tools, it is vital to ensure that the tools are useful. Given the current state of affairs, AI developers should pay more attention to compatibility and efficiency to enhance tools' practical application value, user-friendliness, and user satisfaction. Secondly, the study has shown that ChatGPT's performance is directly related to user satisfaction and users continued use intentions. This raises a key thought for technology developers: human capabilities should not be the sole criterion for evaluating features and functionality; rather, developers should aim to find ways for technologies to exceed human capabilities. Approaching these technologies from a human perspective has its limitations, and more attention should be paid to technologies' overall benefits in terms of meeting users' needs. In conclusion, this study has confirmed the multiple advantages that AI tools can offer and highlighted the fact that AI has already demonstrated its great impact in education. Moreover, the study provides a practical case for personalized learning and adaptive teaching methods, as well as richer learning resources and support for teachers and students. More explicitly, practical application of ChatGPT has broadened the knowledge scope in education. Teachers can enrich their teaching methods and content by using various types of AI, thus creating more opportunities and possibilities for innovation in the education sector. On the flip side, since AI uses machine learning methods that several research organizations have cited, students can experience a richer, higher-quality learning experience.

5.3 Limitations and future research

Although this study has profound theoretical and practical implications, it also has some limitations. Firstly, the study

was limited to college students who had interacted with ChatGPT, which resulted in a relatively small sample. A future research goal is to delve deeper into whether these findings differ across groups, such as among those who are less knowledgeable about AI chatbots. Secondly, the majority of the survey respondents were from within the United States. Hence, ChatGPT's regional popularity as well as country and culture differences may have impacted the research results. Therefore, future research could be extended to an international context to validate the proposed model and further expand the breadth of the study. Finally, the study mainly focused on the inherent advantages of ChatGPT while ignoring possible problems such as privacy protection and the risk of misuse. Given that advanced technologies such as ChatGPT are still in their infancy, there is some concern about their future usage trends. Therefore, future research should examine the roles of privacy and risk perception in the application of new technologies in greater depth, and comparative studies should be conducted to assess the strengths and weaknesses of AI software such as ChatGPT.

6 Discussion

ChatGPT, as a novel technological innovation, is affecting changes in educational management, most notably in the field of higher education. The purpose of this study is to understand the various influences on the use of ChatGPT, an artificial intelligence tool, in higher education. Using structural equation modeling through a questionnaire approach, this study reveals the model of technology acceptance in a higher education setting and further identifies some of the key factors that influence users continued use of ChatGPT as an educational tool. The findings confirm that ChatGPT's compatibility and efficiency directly determine its perceived capabilities, and that perceived ease of use and usefulness are two key factors influencing users' satisfaction with and willingness to continue using ChatGPT. These findings demonstrate the promising development of ChatGPT in the educational context, emphasizing that when students interact with AI-driven educational tools such as ChatGPT, it will further contribute to the promotion of the integration of education and technology, as well as provide a solid theoretical foundation and directional guidance for the wide application and further development of educational technology in the future.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the patients/participants or patients/participants legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

CY: Conceptualization, Formal analysis, Methodology, Software, Writing – original draft, Writing – review & editing. JY: Formal analysis, Project administration, Supervision, Writing – original draft, Writing – review & editing. NC: Conceptualization, Software, Writing – review & editing.

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