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A qualitative analysis of Chinese higher education students' intentions and influencing factors in using ChatGPT: a grounded theory approach

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The emergence of ChatGPT has significantly impacted the field of education. While much of the existing research has predominantly examined the theoretical implications of ChatGPT, there is a notable absence of empirical studies substantiating these claims. As pivotal stakeholders in education and primary users of ChatGPT, exploring the willingness and influencing factors of higher education students to use ChatGPT can offer valuable insights into the real-world needs of student users. This, in turn, can serve as a foundation for empowering education with intelligent technologies in the future. This study focuses specifically on the demographic of students in Chinese higher education who have utilized ChatGPT. Using semi-structured interviews and grounded theory methodology, we aim to comprehensively understand the extent to which students embrace new technologies. Our objective is to elucidate the behavioral inclinations and influencing factors of student users. The findings of this study will contribute practical insights for refining policy frameworks, expanding the dissemination of quality resources, optimizing and upgrading products for an enhanced user experience, and fostering higher-order thinking skills to adeptly navigate evolving technological landscapes. In conclusion, this research endeavors to bridge the gap between theoretical discussions and practical applications.

Keywords ChatGPT, Willingness to use, Grounded theory, Technological revolution, Higher education

In November 2022, OpenAI, a non-profit research organization based in the United States, unveiled ChatGPT (Chat Generative Pre-trained Transformer). This innovative chatbot employs a generative pre-trained neural network model, engaging in interactive conversations through various natural language processing tasks[1–3]. Distinguished by its colossal model parameters and the incorporation of reinforcement learning based on human feedback, ChatGPT has transformed dialogue generation from a single-command-driven approach to realistic, natural conversations. Within a brief span of two months, ChatGPT garnered over a hundred million active users, earning the accolade of being the fastest-growing application in human history, as reported by Reuters, one of the world's top three news agencies[4]. By March 2023, ChatGPT had already evolved to version 4.0. Notably, the estimated parameters for GPT-4 training (1 trillion) surpass GPT-3's parameters (175 billion) by 571 times. This iteration also boasts enhanced capabilities in handling diverse data types, including support for inputting images. Consequently, it can generate responses almost contextually without forgetting the preceding conversation[5]. Faced with the rapid evolution of ChatGPT, experts are reevaluating the profound societal changes it brings. Some scholars even view ChatGPT as a revolutionary force capable of ushering in a utopian future across various industries, while others caution against potential dystopian outcomes.

As one of the latest breakthroughs in Artificial Intelligence for General Chatting (AIGC), the emergence of ChatGPT brings forth new potential and possibilities for the field of education. In July of this year, the United Nations Educational, Scientific and Cultural Organization (UNESCO) released a report titled "Generative AI and the Future of Education," emphasizing the need for education to take a supervisory role in guiding technology, ensuring the learner's agency in the educational process[6]. Positioned as a powerful text-processing language model, ChatGPT not only caters to the diverse learning needs of university students but also generates enthusiasm due to its user-friendly operation and interactive capabilities, as evidenced by statistics from OpenAI.

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According to their data, 62.52% of users fall within the age range of 18–34, with nearly one-third comprising users aged 18–24[7].

Higher education students are direct stakeholders in education and represent a primary user group for ChatGPT. This study focuses on students in Chinese higher education who have used ChatGPT. Utilizing the grounded theory research paradigm, the study involves step-by-step coding of student interview texts to understand their willingness to use new technology and the factors influencing their use of ChatGPT. On one hand, this research aims to genuinely understand the practical needs of higher education students, thereby enhancing their experience with artificial intelligence technologies. On the other hand, from a qualitative research perspective, it delves into the complex factors behind students' acceptance of technology. This provides empirical support for integrating AI technology into educational practice. The findings are not only valuable for educators and technology developers but also contribute to the deeper integration of AI technology in education.

Literature review

Research on ChatGPT

The research landscape around ChatGPT has witnessed a substantial surge in studies since its release, with a concentrated focus on its applications in diverse fields such as medicine[8], foreign languages[9], writing[10], and publishing[11]. Given ChatGPT's relatively short existence and the dependency of some students on it for assignments and exams, there exists a spectrum of attitudes in various countries, ranging from prohibition to neutrality. Current research on ChatGPT can be categorized into two main segments. Firstly, there's a concentration on fundamental theoretical discussions surrounding generative artificial intelligence, with ChatGPT as the representative model. This encompasses discussions on its technical intricacies, real-world impacts, and developmental trends[1,12–14]. Systematically discusses the opportunities and challenges ChatGPT presents to higher education, proposing effective measures for leveraging ChatGPT to transform higher education. [1] utilizing the SWOT framework, conduct a comprehensive analysis of ChatGPT, and present strategies for its integration into education[12]. Explore the opportunities and challenges of ChatGPT in education, revealing a positive sentiment among the majority based on textual data analysis.

Secondly, scholars approach the practical aspects of ChatGPT's role in education from various perspectives, including innovations in learning modes[15], changes in educational paradigms[10,16], and supplementary educational assessments[17]. For instance,[15] conducted a blended study on the Canvas platform, presenting a nuanced analysis of ChatGPT's impact on university students' self-learning experiences, affirming its positive role in personalized learning[10]. Delve into the supportive role of ChatGPT in students' foreign language writing[16], explore the relationship between ChatGPT and teachers, and propose effective avenues for collaboration between teachers and artificial intelligence.

The use and acceptance of new technologies

In the realm of technology-integrated education, scholars have rigorously employed the Technology Acceptance Model (TAM) to investigate the application of new technologies in education. Notable paradigms include online learning[18], educational games[19], and virtual reality[20]. TAM, initially proposed by American scholar Davis, serves as a foundation for explaining and predicting users' acceptance of new technologies and the influencing factors[21]. Over time, scholars have continually validated and refined TAM, giving rise to models like TAM2, UTAUT, and UTAUT2, among others. Acceptance levels, reflecting users' perceptions and attitudes toward new technologies, directly impact their behavioral intentions. Scholars, leveraging TAM, have explored students' acceptance of ChatGPT[22–24]. For instance[23], utilized a structural equation model to analyze 534 university students' behavioral intentions regarding ChatGPT, revealing significant impacts from learners' habits, hedonic motivation, and performance expectations[22]. Applying the UTAUT2 model, investigated determinants of higher education students' intentions to use ChatGPT. Their findings highlighted the significant influence of performance expectations, effort expectations, hedonic motivation, and perceived learning value, with personal innovativeness and information accuracy serving as negative moderating factors[24]. similarly discovered that factors such as perceived usefulness, hedonic motivation, presence, and legitimacy encourage students to adopt ChatGPT more actively, though perceived ease of use did not significantly facilitate this process.

In summary, existing research has explored the impacts of ChatGPT on education from various perspectives, primarily focusing on macro-level theoretical frameworks and analysis. However, empirical studies in this realm are relatively scarce. Current investigations often concentrate on quantifying users' acceptance of new technology and the influencing factors, yet they fall short of delving into the societal and cultural motivations behind real-world issues. Given this context, our study aims to employ Grounded Theory to delve into the willingness of higher education students to adopt ChatGPT. This approach will shift the focus towards the genuine usage experiences of student groups, moving beyond quantitative methods to qualitatively analyze the internal and external drivers influencing students' adoption of new technology. By constructing a comprehensive model outlining the factors impacting the behavioral intentions of ChatGPT users within the student community, our research seeks to provide a deeper understanding of students' acceptance and utilization of this novel technology.

Methods

Research methods and tools

Given the relatively recent emergence of ChatGPT, there is a lack of rigorous scientific paradigms for studying students' willingness to engage with generative AI like ChatGPT. Therefore, this research employs grounded theory and uses semi-structured interviews to gather authentic feelings and user experiences of students using ChatGPT in real-world situations. The collected raw data is then coded through three levels using Nvivo12.On one hand, the study is grounded in Davis's Technology Acceptance Model (TAM)[25–27], incorporating factors such

as Perceived Usefulness (PU)[26], Perceived Ease of Use (PEOU)[25], Attitude Toward Using (ATU)[27], and Behavioral Intention to Use (BI)[25]. On the other hand, based on the grounded theory research paradigm, researchers continuously extract core concepts from the interview texts[28], ultimately constructing a model of factors influencing the use of ChatGPT among higher education students. This integrative approach not only enhances the explanatory power of the model but also provides a new perspective for the application of technology in the field of education.

Procedures and participants

Based on both the official data released by ChatGPT and the preliminary surveys conducted by researchers, it is evident that the primary user demographic for ChatGPT comprises students in higher education. Consequently, this study focuses on the student community within higher education, encompassing undergraduates, master's students, and doctoral candidates. The participants in this research must meet two criteria: firstly, they must be currently enrolled students at universities, and secondly, they must have utilized ChatGPT in their academic pursuits, offering an objective and authentic expression of their experiences and understanding. Table 1 provides essential information about the participants. The study involves students from numerous Chinese higher education institutions, including but not limited to Zhejiang University, Xi'an Jiaotong University, and Shaanxi Normal University.

The collection and organization of raw data constitute a pivotal phase in grounded theory research. To commence, an interview outline was developed, and initial interviews were conducted with five randomly selected participants. Based on these preliminary interviews, the outline was refined to create the formal interview guide. This guide encompasses participants' demographic information, such as age, gender, and education level, and specific interview questions about their user experience and behavioral intentions regarding ChatGPT. These questions delve into aspects such as the participants' opinions and descriptors for ChatGPT, their experiences using the tool, the impacts it has had on them, factors influencing their use, and memorable incidents related to ChatGPT use. During the formal interviews, follow-up questions were posed based on the participants' responses. Before the formal interviews, informed consent forms were signed by the participants, assuring them that all data would be solely utilized for academic research and that their personal information would remain confidential.

Data collation and analysis

The "Grounded Theory," proposed by Glaser and Strauss, stands as a prevalent qualitative research method. This approach considers the researcher as a tool[28–30], emphasizing the collection and analysis of raw data in authentic problem contexts[28]. The foundation of this method lies in constructing a theoretical framework and conceptual structure[30]. Through open coding, axial coding, and core coding, the researcher systematically analyses data in a bottom-up fashion[31]. Following the assessment of theoretical saturation, a comprehensive model of factors influencing the intent of higher education students to use ChatGPT is established.

Open coding

Open coding serves as the initial step in Grounded Theory[32], involving a detailed analysis of interview transcripts to iteratively derive localized categories summarizing phenomena. To ensure coding consistency and reliability, eight interview transcripts were randomly selected. Two researchers engaged in "back-to-back" coding simultaneously. The built-in "coding comparison" feature in NVivo was employed to assess inter-coder reliability, with only coding exceeding 90% consistency deemed acceptable for continuation. Ambiguous text content was collectively discussed to establish a coding list. Ultimately, after consolidating redundant concepts and eliminating irrelevant ones, 31 initial concepts were identified, forming 12 distinct categories. The open coding results are presented in Table 2.

Axial coding

The selection of codes represents the second-level coding in grounded theory. Building upon the open coding process, this stage involves clarifying relationships between concepts, abstracting to form core categories, and specifying the connections between concepts and categories[29,32]. From the initial open coding, 12 independent categories were identified. Through ongoing analysis and comparison of the relationships between these independent categories, four core categories were abstracted: external environment, technological revolution, user experience, and cognitive-emotional aspects.

Indicators	Attributes	Numbers
Sex	Male	12
	Female	20
Education degree	Bachelor	10
	Master	16
	Doctor	6
Professional background	Humanities and social sciences	18
	Science and engineering	14

Table 1. Basic information table ($N = 32$).

Axial coding	Open coding	Reference point content examples
Information dissemination	Media publicity	See a lot of online media publicity; Bilibili has a series of related videos; Browse the public number and find that there are many related recommendations;
	Personal radiation	I will continue to use it in the future and would like to recommend to others;
Community influence	Important others	Friends recommend that it is quite useful; around the use of students, I am also more curious; teachers encourage us to use it;
	Professional background	I am a computer-related professional, very early know CHATGPT;
Facilitating conditions	Hardware support	I use it on my computer a lot, I need an electronic device to use it, and I need a network connection if it takes a while for slow content to be generated;
	Supporting resources	I read the official guide before using it; before using the relevant video resources, taught me how to use it;
Value perception	Objective evaluation	Using CHATGPT has greatly improved my learning efficiency, I find it very efficient and convenient; compared to similar products, the use of ChatGPT is very interactive;
Output quality	Comparative advantage	It has a certain learning ability and can constantly optimize the answer;
	Poor timeliness	The database only updated to September 2021, the latest data can not be obtained;
	Lack of intelligence	Generated content is based on the existing content of the patchwork, Lack of deep understanding, all sometimes serious "Nonsense";
	Lack of personality	Can not maintain personal style preferences;
Potential risks	Data security	The spread of false information, threats to academic integrity;
	Education and teaching	Threatening academic ethics; Social Justice, aggravating the digital divide;
	Social justice	Exacerbating the digital divide; Replace part of the post;
	Security risks	Whether there will be self-awareness in the future;
Technology expectations	Performance expectations	Can help me solve the needs of the moment; the ability to process text is outstanding, compared to the human to find integrated data, it is simply too powerful;
	Effort expectancy	Recently I used it in Polish English papers and words, grammar changed very authentic;
User usage	Use the version	ChatGPT 3.5; ChatGPT 4; related derivatives; localization products;
	Purpose of use	Search and extract text; explain academic concepts; Polish and translate papers; generate text frames; inspire; write and modify code; assist in data processing; entertain chats…
	Task Type	Urgent task: use it to complete more urgent tasks; Auxiliary tasks: mainly or auxiliary-based, it is a good secretary; Non-essential tasks: sometimes use ChatGPT if you don't want to do your research and it's not particularly important;
	Frequency of use	Needs determine the frequency of use; Emotions influence the frequency of use;
Perception barriers	Technical barriers,	ChatGPT has certain technical barriers, and many students because of the registration process cumbersome and give up trying; The development company is foreign, and the product is not Chinese enough;
	Education professional	Education level: undergraduate, master, Doctor with a little more, K12 stage students rarely use; Professional Identity: Computer Professional, humanities and social sciences field, text creators used more;
	Ability perception	Using CHATGPT requires a certain amount of knowledge and experience, and different ways of asking questions can affect the quality of the generated content. You need to judge the value and credibility of the generated content, and a lot of it won't fool the "Expert";
Future expectation	Optimization iteration	Future expectation, optimization iteration, personalization, and personalization; Miniaturization and portability; Emotional interaction; Product localization;
Emotional attitude	Positive emotion	It's a very handy tool; I think the benefits of CHATGPT outweigh the risks; I think it's very reliable, and I believe in the feedback it gives;
	Negative emotions	I did not think it would be self-deception, subsequent use of it often worry about the authenticity of the content produced; After using the feeling did not meet the expectations of the heart, After the gradual lowering of expectations;
	Neutral feelings	Treat a new emerging technology is more of a spectator mentality;
Personal awareness	Technical ethics	Some students use CHATGPT to help complete open-ended questions, I am not sure whether it is right to do so;
	Necessary ability	Information discrimination ability; questioning ability; Life-long learning ability; Creative thinking; critical thinking…
	Reality effects	Chatgpt will force traditional education reform, education needs to train more creative talents, rather than mechanical indoctrination; In the future, we can enjoy higher value service with lower labor costs, it will certainly replace some of the posts, but at the same time it will create new posts;

Table 2. Open coding table.

Selective coding

In the process of selective coding, on the foundation of determining core categories, the aim is to specify the relationships between the core categories and the main categories[28,29,31]. See Table 3 for details. The central focus of this study is the "Determinants of Behavioral Intentions of ChatGPT Users in University." Through comparative analysis, it becomes evident that external objective conditions (external environment, technological revolution) and internal subjective factors (user experience, cognitive-emotional aspects) are the primary influencers shaping the usage patterns of ChatGPT among student populations.

Theoretical saturation test

The two coders of this paper have educational backgrounds, which can ensure an open and objective attitude to analyzing the interview text. A total of 50 student users were interviewed voluntarily, and the interviews were

Core category	Axial coding	Meaning
Outside environment	Information dissemination	The dissemination of information in daily life affects the individual's cognition of new technology
	Community influence	The influence of social factors and surrounding groups on individual behavior will
	Facilitating Conditions	Objective factors that drive users to ChatGPT
Technological revolution	Value perception	ChatGPT has advantages over its peers;
	Output quality	Defects and deficiencies of current technology
	Potential risks	The potential dangers of ChatGPT
Use experience	Technology expectations	Users expect ChatGPT to meet their needs
	User usage	The specifics of CHATGPT for users
	Perception barriers	Factors that prevent users from using ChatGPT
	Future expectation	User recommendations for ChatGPT upgrade optimization
Cognitive emotion	Emotional attitude	Users' personal emotional bias toward technology
	Personal awareness	The self-understanding built up throughout use

Table 3. Axial coding table.

conducted simultaneously with the coding. The results show that from the 32nd interviewee, new concepts and categories no longer emerge in the coding content, which has reached the state of theoretical saturation[33].

ChatGPT behavior intention influence factor model construction

Analyzing the relationship between the main categories and core categories reveals that the external environment's real impetus and the empowering force of technological revolution serve as the external driving forces for users to adopt ChatGPT, directly influencing individual usage intentions. Simultaneously, user experience and cognitive-emotional aspects collectively constitute internal driving forces, interacting with each other and compelling users to delve deeper into understanding and continuously using ChatGPT. Among these factors, users exhibit three different emotional attitudes towards ChatGPT: positive, negative, and neutral. Davis's Technology Acceptance Model also indicates that user attitudes directly influence behavioral intentions, and behavioral intentions are closely linked to actual behavior[25,27]. Analyzing interview texts similarly uncovers that emotional differences drive users to develop different usage intentions, namely positive technological acceptance, negative technological resistance, and maintaining a neutral observant stance. Thus, this paper constructs a model illustrating the factors influencing ChatGPT usage intentions among higher education students, as depicted in Fig. 1.

Ethical approval

All the methods were carried out in accordance with relevant guidelines and regulations. Ethical approval for the study was obtained from the Ethical Review Committee of Shaanxi Normal University, Faculty of Eduscation. Permission was written informed consent was obtained from each study participant. Students were informed of the purpose of the study, and the right to refusal and withdrawal from the study was respected. All procedures performed in studies involving human participants were in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

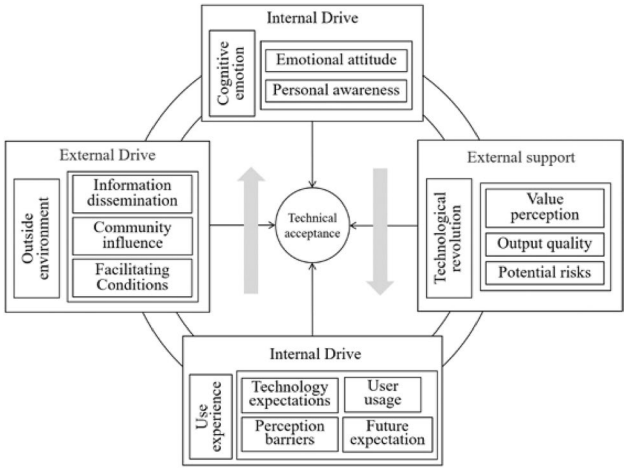

Figure 1. ChatGPT Uses a willingness-to-influence factor model.

Results

The external environment is the external driving factor that promotes the user to use

In the era of modern media, information dissemination has become more immediate and widespread, enveloping individuals in a myriad of information. Those living in the real world are subject to the influences of a complex external environment. Since the emergence of ChatGPT at the end of 2022, news media and online platforms have promptly reported on ChatGPT, capturing the public's attention. Nearly all interviewees mentioned keywords such as "news," "Bilibili," and " Public number". When discussing their first encounter with ChatGPT: "I first heard about it during the period when it was trending online. I checked various sources online, but I hadn't used it at that time" (M8); "The official accounts I follow pushed content about ChatGPT" (B4); "I came across it through shared content on Bilibili" (M1). Modern online media provides a favorable avenue for information transmission[34], yet some users noted that although they became aware of ChatGPT through online media, there was still a time gap between awareness and usage.

To delve into the reasons behind the phenomenon, the researchers further questioned the interviewees with a series of inquiries such as "Why were you aware of ChatGPT but did not try it immediately?" and "What prompted you to start using it?" In-depth exploration revealed that, in contrast to societal dissemination through online media, community influence stands out as the direct force compelling users to formally adopt ChatGPT. Community influence refers to the impact of the surrounding community on individuals, encompassing significant others and professional backgrounds. Many users expressed how positive feedback from peers played a pivotal role: *"A friend recommended it, saying it's pretty useful, so I decided to give it a try"* (M11). Authoritative influence from teachers and experts was another significant factor: *"During the research process, a teacher recommended it, and that's when I began trying it out"* (M3). Important individuals proved to be crucial factors in igniting strong usage intentions. This point is confirmed in the study by[35]. Conversely, negative hearsay or subpar experiences within the community also emerged as hindrances to user adoption.

Additionally, professional backgrounds led to varied sensitivities among users. Students in computer-related majors were more inclined to understand and experiment with ChatGPT early on: *"I'm a computer science major, and I knew about ChatGPT even before its official release"* (M2). On the other hand, students in disciplines such as accounting, mathematics, and physics indicated that few of their peers used ChatGPT, and some were unaware of its existence. This divergence may be attributed to ChatGPT's proficiency in handling textual content, with less prowess in mathematical computations[2]. Evaluated ChatGPT's performance in economics, medical education, law, and other fields through examinations. The study found that ChatGPT performed well in programming and English; however, its performance in mathematics, software testing, sports science, and psychology was less satisfactory.

Furthermore, respondents highlighted the hardware prerequisites for ChatGPT usage, emphasizing the need for electronic devices and a reliable internet connection. *"I typically use ChatGPT on my computer; it requires an internet connection, and if the network is slow, content generation takes a bit longer"* (M9). Access to support resources, such as official manuals and instructional videos, facilitated a smoother onboarding process: *"I read the official guide before using it, gaining a clearer understanding of how to use it"* (D2); *"I watched relevant tutorial videos before using it"* (M5). Moreover, a majority of student users expressed their willingness to recommend ChatGPT to others. Their endorsements have the potential to drive more users, expanding ChatGPT's influence and creating a virtuous cycle.

The technology revolution is the external supporting factor that enables the user to use

The technological revolution encompasses perceived value, output quality, and potential risks. Firstly, perceived value involves the user's overall assessment of ChatGPT, encompassing objective evaluations and the relative advantages of the technology. Examples include:

1. Efficiency and Convenience: Users highlighted the efficiency and convenience of ChatGPT, emphasizing cost reduction and improved productivity. *"It enhances efficiency, refines searches, and becomes more intelligent"* (B2); *"Its strong text integration and rapid answer production make learning highly efficient"* (M5).
2. Strong Interactivity: Users appreciated ChatGPT's human-like interaction, allowing for in-depth communication. *"The conversation is quite personable; you can engage in deep conversations, and it responds with queries. It feels different from interacting with a search engine"* (M2).
3. Timely and Accurate Responses: Users acknowledged ChatGPT's ability to address the information overload on the internet, providing direct access to useful information. *"It compensates for the negative consequences of internet inflation, directly extracting valuable information from vast and complex data"* (D2).

Secondly, relative advantage refers to the specific strengths of a technology compared to similar products. In contrast to other intelligent interaction devices, ChatGPT boasts an extensive database, powerful training algorithms, and the ability to self-improve: "During interactions, it continues to learn; it promptly corrects itself after you point out errors" (M7). ChatGPT marks a shift from perceptual intelligence to cognitive intelligence in artificial intelligence. It not only generates more natural response text based on user input and requests, facilitating language translation, question answering, and text generation tasks efficiently[36] but also provides users with more personalized and autonomous services.

Technological drawbacks gradually emerge in the course of using ChatGPT. 80% of the respondents indicated inconsistent output quality, attributed partly to the database only being updated until 2021, resulting in poor timeliness of generated content[36]. Additionally, ChatGPT exhibits limited intelligence and personalization; it heavily relies on existing databases and learning models, lacking inherent high-level thinking capabilities and the ability to generate profound insights. Faced with knowledge gaps, it may resort to misinformation or even

fabricate content convincingly[1,2,35]: *"Sometimes it talks nonsense; for things, it doesn't know or hasn't been trained on, it can make things up'* (D5); *"It recommends entirely fake papers" (D3); "You shouldn't expect all the information it provides to be reliable"* (B5). Consequently, many respondents harbor strong concerns, expressing apprehension about the potential risks associated with the rapid development of technology. These concerns manifest in various aspects, including data security (risks of important data leakage and proliferation of false information)[37], education of talent (threats to academic ethics and erosion of higher-order cognition)[12], social equity (exacerbation of the digital divide and displacement of certain positions)[1], and technological hazards (the emergence of a sense of autonomy)[2]. The users' crisis awareness underscores the need for careful consideration and mitigation of these risks as technology continues to evolve.

User experience is the internal supporting factor that influences user usage

User Experience (UX) refers to the overall experience users have when interacting with a product or service. The user's experience not only accurately reflects the adaptability of the technology, promoting technological updates and iterations, but also a positive user experience generates a beneficial social impact, consequently expanding the influence of ChatGPT. Therefore, researching the intrinsic connection between user experience and usage intention is crucial. User experience can be divided into four dimensions: technological expectations, usage scenarios, perceptual obstacles, and future expectations.

Technical expectations

Technological expectations encompass users' anticipations regarding the capabilities of the technology, including performance expectations and effort expectations. Performance expectations involve users' perceptions of how ChatGPT enhances their efficiency. For instance, one user expressed, *"Compared to other search engines, ChatGPT's ability to gather and integrate information is remarkable. It helps me extract key points from redundant information, significantly improving my learning efficiency"* (M9). Users acknowledge the powerful functionality of ChatGPT in addressing real-world problems, and performance expectations directly influence user utilization, aligning with studies by Strzelecki and Foroughi et al.[22,23]. Effort expectations pertain to users' expectations regarding the ease or difficulty of using the technology. Users find ChatGPT's interface straightforward and highly convenient, allowing for immediate use upon launch. Therefore, effort expectations are a crucial factor influencing user utilization[34], indirectly impacting users' behavioral intentions by affecting performance expectations . However, some respondents mentioned, *"ChatGPT's operation is straightforward and easy to understand, but many students around me gave up using it due to the cumbersome registration process. This is more evident among females"* (B1). Gender differences contribute to varying sensitivities to technology, with females being more influenced by perceived usability.

User usage

User engagement refers to an individual's subjective agency, representing a pivotal factor that drives users to utilize technology. It encompasses factors such as the version used, the purpose of use, task types, and frequency of use. Presently, student users engage with various versions, including ChatGPT 3.5, ChatGPT 4, related derivative products, and localized versions. Users leverage ChatGPT for tasks such as explaining concepts, generating inspiration, creating frameworks, assisting in writing, information retrieval, refining translations, coding, and data processing. For instance, student D6 states, *"I used it to assist in revising and polishing my English papers. It can make challenging aspects of Chinese-style English sound very natural. Its performance in this regard is excellent, and now I hardly use any other software for proofreading."*Individuals also occasionally use ChatGPT for leisure and entertainment, as mentioned by student M2: *"Sometimes when I'm bored, I ask it illogical questions or have it generate jokes. Whenever it earnestly spouts nonsense, I find it amusing, which helps regulate my mood."* Achieving the intended purpose contributes positively to users' feedback. Despite ChatGPT's robust capabilities, some users remain cautious due to its perceived unreliability. Most users prefer to use ChatGPT for urgent, supportive, or non-critical tasks. As student M6 articulates, *"People say ChatGPT can save you time and quickly find a lot of materials. However, when the pressure isn't particularly high or time is tight, I prefer to research on my own. I feel that in the process of searching for information, I'm enriching myself. Even if it generates content for me, I will review and correct it item by item. I don't directly use it, and I feel that using its content directly would limit my thinking."* The process of researching information is also a learner's self-construction journey. Introducing a moderate cognitive load can stimulate learners' intrinsic motivation more effectively. Simplifying the complex process of knowledge acquisition through technology, presenting results directly to users, and habitually relying on technology to achieve goals may lead learners to gradually lose their ability for independent thinking, posing a potential threat to education. Moreover, different users have diverse requirements for ChatGPT. Many respondents indicate that individual needs determine usage frequency, and emotions during usage also impact the frequency. The subjective willingness of users is the driving force behind their continuous use of ChatGPT.

Perception barriers

Users have encountered various obstacles during their usage. Firstly, there are technological barriers as the product is developed by a foreign company, resulting in a noticeable cultural gap during usage. The registration process is complex, requiring a certain technical proficiency for users in China. Secondly, the users' educational background and major play a role in adoption; undergraduates, master's, and doctoral students use it more frequently, while students in basic education use it less. Professions in computer-related fields, humanities, textual work, and arts tend to use it more. Additionally, users' knowledge base, higher-order thinking abilities, and value judgment also impact the user experience. For example, a user mentioned, "If the question is in an area I'm not familiar with, I cannot judge whether what it tells me is true or false" (M3). Therefore, users need

strong subjective judgment abilities to avoid the proliferation of false information. The difficulty in distinguishing between true and false content and the relatively high usage threshold in China are the main reasons discouraging domestic students from using the platform. Perceptual obstacles significantly decrease users' willingness to use and harm their intentions.

Future expectation

Addressing the existing shortcomings, student users have expressed their future expectations for ChatGPT. These include obtaining the latest data, precision in information processing, downsizing, and personalization, enhanced emotional interaction, and localization of the product. Users' future expectations can provide valuable insights into the ongoing development of the technology, contributing to its better integration into educational contexts.

Cognitive emotion is an internal driving factor to promote user use

Emotional attitude

The advent of ChatGPT has garnered widespread attention, eliciting various emotions such as excitement, curiosity, concern, and anxiety among users. User attitudes directly impact behavioral intentions, subsequently influencing usage behavior[34]. This study employs Daniels' three-dimensional emotion categorization method, classifying user emotions as negative, positive, or neutral[38]. Negative emotions weaken users' technological expectations. For instance, student M5 expressed, "It deceived people before, and every time I use it, I feel a bit worried, afraid it will fabricate information again." The autonomous fabrication of information by the technology has raised concerns among users about its future development. Some participants worry about ChatGPT potentially replacing jobs, exacerbating human laziness, or even operating beyond human control. These concerns lead to strong resistance among users, leaning toward a technological threat perspective, influencing the willingness to restrict technological development. Despite the existing flaws, some users find the drawbacks tolerable compared to ChatGPT's prominent advantages. They appreciate its rapid updates, progressing from version 3.5 to 4.0 within a few months, anticipating significant performance improvements in the future. Some users even express an "unexplained sense of trust" in ChatGPT, finding its generated answers more convincing than information obtained from search engines (B1).

Consequently, users' acceptance of intelligent technology varies widely, with positive emotions prompting a willingness to embrace technological development. Neutral emotions represent an emotional midpoint, encompassing objectivity, neutrality, and calmness. Student D2 stated, "My excitement gradually turned into calm skepticism because we realize it also has its shortcomings." When encountering something new, most people initially adopt an observational stance driven by curiosity. As users delve deeper into understanding the technology, their emotions undergo a transformation from excitement to a more subdued state, leading them to contemplate how to leverage the technology's strengths for their benefit. Neutral emotions encourage users to maintain a neutral, observant attitude toward its use.

Personal awareness

Personal cognition refers to the self-understanding gradually constructed by users during the use of technology. This encompasses the real-world impacts of ChatGPT and the essential capabilities for future talent. The emergence of ChatGPT is a groundbreaking innovation, bringing about significant societal changes. It enhances information accessibility, promotes personalized learning, and allows humanity to enjoy high-value services at a lower cost[35]. As expressed by user M2, *"It is a convenient tool, much like the steam engine replacing the carriage, improving productivity. It is undoubtedly a great thing for human society. The creation of new technology opens up more possibilities for humanity."* Users anticipate ChatGPT to drive traditional educational reforms, emphasizing the need to cultivate creative talents rather than mechanical indoctrination.

However, some users exhibit a strong sense of self-crisis, particularly those in humanities and social sciences who fear the technology's potential to replace their job positions. Concerns about misinformation proliferation, threats to academic integrity, deepening digital divides, declining high-level cognitive skills, job displacement, and the emergence of autonomous technology pose challenges. Faced with these potential risks, users emphasize the necessity for future talents to possess lifelong learning abilities, information discernment skills, and effective questioning skills. They underscore the importance of critical thinking and creative thinking as advanced cognitive abilities. Recognizing the dual nature of any technological advancement, users need to adopt a dialectical perspective. A well-rounded personal cognition helps users gain a comprehensive understanding of the technology, enabling them to regulate their usage behavior effectively.

Discussion

Improve policy framework and expand the dissemination of quality resources

On September 7, 2023, UNESCO released the "Guidance for Generative AI in Education and Research"[39], the first guide on using generative AI in education. The rapid pace of technological advancements often surpasses existing regulatory frameworks, leading to frequent incidents of students misusing ChatGPT[1,2,12]. One interviewee mentioned, "Some classmates use ChatGPT for open-book exams, and I'm not sure if this is appropriate." Hence, there is an urgent need to enhance the relevant policy framework. Governments and educational institutions should establish clear standards for using ChatGPT, covering ethical norms, data privacy, and intellectual property, to ensure its legal and effective use[35,40]. Educational institutions should prepare verification tools and provide high-quality educational products to enhance the learning experience[41]. Developers of educational products should create quality learning resources and leverage media for dissemination. By introducing basic concepts, working principles, and practical applications, they can help students quickly build technical understanding[42]. Additionally, detailed operation manuals and prompt writing guides can help students quickly familiarize themselves

with the technology and obtain higher quality generated information. These learning resources can help students better understand and apply new technologies, improving learning efficiency and skill levels.

Focus on product optimization and enhance user experience

User experience is positively correlated with behavioral intention[25,26]. Analyzing user intention and its influencing factors reveals that factors such as output quality, potential risks, and perceived barriers negatively impact user intention[24,34]. To enhance students' experience with ChatGPT, technical developers need to focus on product optimization and upgrades. Firstly, improving content output quality is crucial, as low-quality and difficult-to-evaluate generated answers significantly impact user experience. Developers can improve ChatGPT's accuracy by training on larger datasets and optimizing model algorithms to ensure users receive high-quality answers[24]. Secondly, continuously collecting user feedback and implementing regular updates allows developers to identify and address issues promptly, maintaining a positive user experience. Additionally, reducing potential risks associated with the technology is essential. Due to the "black box" nature of machine learning, data operations are opaque to users, making it challenging to discern the authenticity of information[17]. Increasing transparency or providing interpretive tools can help users trace information sources, better understand the decision-making process, and evaluate the reliability of answers, thus mitigating the spread of false information. Finally, reducing perceived barriers is necessary. Issues such as inadequate loca

Cultivate advanced thinking skills to adapt to technological evolution

In the future, the learning and knowledge mastery capabilities of intelligent technologies will far surpass human abilities. Society will require talents who can flexibly apply, transfer, and innovate rather than merely excel in exam-oriented knowledge. Building a personal cognitive system often requires continuous interaction with the real world and accumulating experience. However, the excessive use of generative AI is gradually depriving students of the opportunity to develop such skills. Students no longer actively think about problems but rely on AI for "ready-made answers," becoming increasingly dependent on the convenience of AI and ultimately losing the ability to think independently. Therefore, it is crucial to cultivate students' critical thinking[42], enhance their ability to think independently and solve problems, and encourage them to express their opinions boldly while reducing their dependence on technology. Emphasizing the development of logical reasoning skills is important, as it involves seeking the truth through observation, analysis, reasoning, and argumentation. Developing the ability to solve complex problems is also vital, as higher-level knowledge involves the flexible application of facts[43]. Using flat knowledge to solve real-world problems is a process of transforming composite knowledge into three-dimensional understanding. Research by[37] shows that students' digital literacy levels affect their use of technology. Enhancing students' digital and information literacy can help them identify information sources and evaluate the accuracy of ChatGPT-generated content, effectively mitigating potential risks. Additionally, understanding technology ethics is important, as technological advancements often exceed human imagination, potentially crossing ethical boundaries. Students need to be aware of technology ethics[44], particularly higher education students who must adhere to academic integrity principles when using ChatGPT, avoiding the direct use of AI-generated academic content to reduce plagiarism and academic misconduct risks[35]. Therefore, students should develop a correct and reasonable understanding of technology, view it dialectically, and understand the working principles, limitations, and impacts of technologies like ChatGPT. By recognizing strengths and avoiding weaknesses, they can maximize the value of technology while remaining cautious of becoming overly enthusiastic advocates or passive resistors.

Conclusion

The research reveals that the willingness of higher education students to use ChatGPT is primarily influenced by objective conditions such as the external environment and technological revolutions, as well as internal subjective factors such as user experience and cognitive emotions. The interaction between these factors leads users to gain an in-depth understanding and continue using ChatGPT. In the future, by implementing policy regulations, enhancing resource dissemination, improving users' higher-order thinking skills, and optimizing the technology, we can enhance the user experience and drive the sustainable development and innovation of artificial intelligence technologies like ChatGPT in the field of education.

However, this study has several limitations. Firstly, the small sample size and the homogeneity of data sources may limit the external validity of the results. Future research should aim to expand the sample size, encompassing a wider range of regions and different types of higher education institutions to enhance the generalizability of the findings. Secondly, while the qualitative methods employed in this study allow for an in-depth exploration of students' experiences and the factors influencing their use of ChatGPT, the subjective nature of the data may introduce interpretive biases. Subsequent research should incorporate quantitative methods to further validate the conclusions drawn from this study. Lastly, due to the rapid development of ChatGPT technology, the results of this study may be affected by technological advancements. Therefore, future research should continuously monitor the impact of technological updates on the educational field.

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding authors upon reasonable request.

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Author contributions

Zhaoyang Liu is in charge of data collection and analysis, chart making, paper writing. Wenlan Zhang is in charge of revising the article. All the authors reviewed the manuscript.

Competing interests

The authors declare no competing interests.

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