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Understanding CFL Learners' Perceptions of ChatGPT for L2 Chinese Learning: A Technology Acceptance Perspective

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Abstract: While ChatGPT has received increasing attention in the age of artificial intelligence, little effort has been made to investigate Chinese as a foreign language (CFL) learners' acceptance of ChatGPT use for Chinese learning. This mixed-method study aims to unpack CFL learners' intentions and perceptions of leveraging ChatGPT for learning purposes by integrating the technology acceptance model and social cognitive theory. To this end, quantitative data were collected from 120 CFL learners by using questionnaires tapping into perceived ease of use, perceived usefulness, behavioral intention, facilitating conditions, and growth mindset, and analyzed by partial least squares structural equation modeling. Quantitative data were supplemented by qualitative data in the form of learners' responses to an open-ended question. Quantitative results indicated that perceived usefulness, growth mindset, and facilitating conditions were significant antecedents of learners' intention to use ChatGPT, while perceived ease of use was not. The qualitative findings revealed students' varied perspectives on integrating ChatGPT into the Chinese learning process. The study sheds light on the underlying mechanisms of CFL learners' behavioral intention to use ChatGPT and provides context-specific and nuanced insights into CFL learners' perceptions of ChatGPT-assisted language learning.

Keywords: ChatGPT; Chinese as a foreign language; artificial intelligence; technology acceptance model; mixed methods

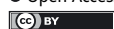
1 Introduction

In the post-pandemic era, artificial intelligence (AI) technologies have been facilitating digital transformation in educational systems worldwide, revolutionizing the

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way language learning and teaching are approached (Ahmad et al. 2021; Holmes and Tuomi 2022). ChatGPT, as a powerful Generative AI tool, can generate human-like responses and engage in text-based conversations with users, exhibiting great potential for application in language education (Kasneci et al. 2023). For teachers, ChatGPT can serve as an intelligent and practical aid for classroom teaching (e.g., linguistic skills instruction) and resource building (e.g., multimedia teaching materials). For learners, it can offer customized guidance tailored to individual needs, addressing questions and offering feedback anytime and anywhere.

However, despite its advantages, challenges and ethical concerns arising from integrating ChatGPT in foreign/second language (L2) learning and teaching influence stakeholders' attitudes and adoption of AI technologies (Hong 2023; Selwyn 2022). For example, students may lack motivation to use ChatGPT due to its inaccurate responses, operational difficulties, limited access to this technology because of the potential risk of academic misconduct (Abdulahdi 2023). While promising results have demonstrated ChatGPT's affordances, application, and effect in language learning (Kostka and Toncelli 2023; Zhang and Tur 2024), it is imperative to investigate users' willingness to successfully use this technology for language learning from students' perspective.

Widely acknowledged theory for evaluating technology acceptance is technology acceptance model (TAM) proposed by Davis (1989). The model posits that the perceived ease of use (PEU) and usefulness of a technology significantly influence users' intentions to adopt it. In the context of language learning and teaching, by utilizing the TAM, researchers can predict English as a foreign language (EFL) learners and teachers' willingness to adopt a certain technology based on their perceptions (Liu and Ma 2023; Zhang, Hennessy, and Pérez-Paredes 2023).

Nevertheless, it is crucial to recognize that adopting new technologies, especially AI applications, may create difficulties and burdens for users and user may be influenced by specific environmental conditions (Saif et al. 2024). According to social cognitive theory, learners' behaviors are influenced by both internal, such as personal belief and external factors, such as available resources (Schunk and DiBenedetto 2020). Therefore, domain-specific growth mindset (Lou and Noels 2019), namely belief in one's ability to use technology can be cultivated or not and facilitating conditions (Bervell et al. 2022), namely perceived technological support from the environment could be noteworthy factors facilitate or hinder users' ChatGPT adoption. While TAM variables have been extensively examined among EFL teachers and learners, the influence of social cognitive factors beyond TAM has not been sufficiently explored (Bai, Wang, and Chai 2021). Additionally, there has been limited attention to the acceptance and perceptions of Chinese as a foreign language (CFL) learners regarding the use of ChatGPT as a tool for assisting in their Chinese language

learning, particularly among international students studying in China for whom Chinese is a second or third language (Chen and Yuan 2023).

In this context, this study aims to offer a fresh perspective by incorporating social cognitive theory into the established TAM framework. Specifically, it intends to examine the roles of both individual, namely growth mindset and environmental factors, namely facilitating conditions in technology acceptance among CFL learners in a novel setting of ChatGPT-assisted L2 Chinese learning. Theoretically, the innovative integration of social cognitive theory and TAM represents the first attempt to investigate the potential synergies between these theories, enriching the existing literature on ChatGPT that support language learning. Practically, by contextualizing the investigation of the psychological mechanisms of CFL learners' acceptance of ChatGPT, the study provides valuable insights for policymakers and educators who intend to incorporate ChatGPT into language teaching to improve learners' motivation, interest, and learning outcomes.

2 Literature

2.1 ChatGPT and Language Learning

ChatGPT (Generative Pre-trained Transformer, GPT-3) is an advanced AI-powered tool released by the United States-based startup OpenAI in November 2022 (Meyer et al. 2023). Relying on resources and information from a large language model, it was designed to provide tailored suggestions and answers in accordance with users' specific needs. Notably, the newly released GPT-4 in March 2023 is equipped with more sophisticated capabilities for producing multimodal content, including both visual and textual materials. Unlike earlier chatbots which struggle to answer complicated questions, ChatGPT excels in engaging in coherent conversations with users and providing them with consultation services, which paved the way for its application in language learning.

There has been a heated discussion on ChatGPT since it was launched. Scholars have explored the possibility and effectiveness of incorporating this technology into language education. As Li et al. (2023a) noted, ChatGPT can provide explicit and corrective feedback and personalized learning experiences, which may facilitate language acquisition and enhance learning motivation. For example, among 50 EFL students Song and Song (2023)'s experimental research proved that ChatGPT-assisted instruction could enhance the quality of academic writing in terms of organization, coherence, grammar, and vocabulary. In addition, qualitative findings derived from semi-structured interviews unveiled the positive role of ChatGPT in enhancing students' confidence and engagement. Similarly, Li, Li, and Cho (2023)'s three-week

intervention demonstrated that CFL learners from low-income families all made significant improvements in their writing scores attributed to ChatGPT usage, which is inspiring for educational equality. Despite the benefits of ChatGPT applications, scholars also noted the limitations, challenges, and concerns of the technology, such as lack of awareness of cultural nuances, risk of substituting human teachers, academic misconduct, privacy leakage, and so on. Against this backdrop, stakeholders held mixed feelings toward ChatGPT use (Yu 2023).

However, relatively few studies examined learners' attitudes toward ChatGPT use for language learning and what factors facilitate or hinder their use of this technology. Additionally, research on language education has long been dominated by studies on English teaching and learning, which posed challenges for the diversity of language education (Gong, Lai, and Gao 2020). The last decade has witnessed the increasing popularity of Chinese language education within and outside China (Gong, Lyu, and Gao 2018). Nevertheless, many CFL learners perceived Chinese learning as difficult due to the distinctive tonal and orthographic systems of Chinese, which caused negative emotions and weakened learning motivation (Luo 2014). Moreover, in response to challenges facing CFL learners, such as insufficient teachers' feedback and inadequate oral practice (Xu and Peng 2017), ChatGPT is an effective tool for self-directed Chinese learning, providing extensive and accessible guidance. Therefore, a more nuanced understanding of the determinants of CFL learners' intention to use ChatGPT for Chinese learning is imperative to offer practical implications for AI-assisted CFL education.

2.2 Theoretical Background

Technology acceptance model (TAM) developed by Davis (1989) has been recognized as a powerful framework that explains individuals' adoption, rejection, and utilization of new technologies. The classic TAM (see Figure 1) posits that two core dimensions, perceived usefulness (PU) and PEU of technology, determine users' attitudes towards technology (AUT) and behavioral intentions (BI) to use a new technological tool and the latter finally predicts actual usage (AU) of the tool. Meanwhile, in addition to these key variables, various external variables that are not precisely defined can affect these two perceptions. Later on, numerous scholars argued that these external variables required sufficient specification or the model's application might be severely restrictive (Hubona and Kennick 1996). In this context, new dimensions, facilitating conditions (Venkatesh and Davis 2000) emphasizing environmental characteristics were integrated into TAM to offer a more thorough clarification and prediction of the model. This environmental variable can be defined as user perceived technological support in a specific social context. A considerable

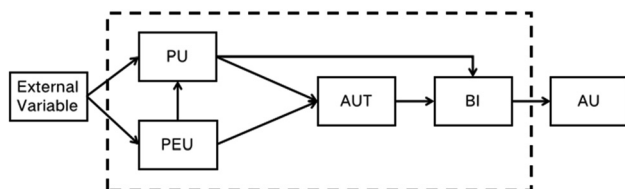


Figure 1: Technology acceptance model. Notes: PU: perceived usefulness; PEU: perceived ease of use; AUT: attitude toward technology; BI: behavioral intention to use technology; AU: actual use of technology.

amount of research in education has verified the significant and robust predictive role of these perceptions and facilitating conditions in users' adoption of new technology (Bai, Wang, and Chai 2021; Sun and Mei 2020; Liu and Ma 2023). As noted by Bervell et al. (2022), this variable is crucial when considering technology affordance in developing countries and determines students' acceptance of Google Classroom.

However, most of external variables beyond the original TAM model introduced focus on the special characteristics of new technologies with learner's initiative and individual characteristics neglected. According to social cognitive theory (Bandura 1986), individual behavior is influenced by a combination of socio-environmental and individual factors. The theory emphasizes personal agency, highlighting that individuals are both creators and products of the social systems they navigate. It is one's motivational beliefs that empower individuals to exert control over their personal trajectories and the larger societal landscape (Bandura 1999). Therefore, personal beliefs are believed to be strong determinants of individuals' actual use of a specific technology (Liaw and Huang 2013). Empirically Bai, Wang, and Chai (2021), have conducted research among language teachers and unveiled the crucial role of computer self-efficacy in influencing utilization of information and communication technology (ICT).

That said, some scholars also have pointed out that there is a high degree of similarity between computer self-efficacy and PEU (Sun and Mei 2020), so this research still utilized perceived ease of use, which is one of the core components of TAM, as the main predictive variable. Instead, growth mindset, as a crucial but under-explored learner-internal factor, was included in this conceptual model. The construct is defined as one's belief that his capabilities, skills, and talents can be improved through effort (Dweck 2006). As a strong motivational belief, it affects individual's agency in navigating life's complexities and resilience in embracing challenges (Bai, Wang, and Chai 2021). Scholars noted the manifestation and impact of a growth mindset can vary significantly across different subjects, tasks and other

domains (Khajavy, Pourtahmasb, and Li 2021), which necessitates adopting a domain-specific perspective when conducting research delving into this learner-internal factor (Li, Hiver, and Papi 2022). Since ChatGPT technology is relatively new and its proper utilization is difficult to a certain extent (Hadi Mogavi et al. 2024), learners may not be proficient in its use for language learning. Therefore, it is assumed that in the context of ChatGPT-assisted Chinese learning, this proactive mindset in ChatGPT will encourage users to engage with the complexities of using ChatGPT for language learning allowing them with curiosity rather than frustration. In other words, those embracing a growth mindset will be more engaged in learning to use this new technology despite operational challenges.

Looking at the research field of CFL, there are few quantitative studies based on TAM to explore learners’ acceptance of ChatGPT with a focus predominately on teachers’ ICT use on a macro level. Theorists have emphasized that variables in TAM require contextualized definitions and items to better evaluate the relationships between these factors (Liu, Darwin, and Ma 2024). In addition, more specific external variables, namely the variables beyond TAM, need to be introduced to enhance the explanatory power of the model for a more comprehensive understanding of how users accept and use new technologies can be achieved. Therefore, this study aims to conduct a domain-specific investigation in a ChatGPT-assisted Chinese language learning context among CFL learners, considering potential environmental and personal factors, including facilitating conditions and growth mindset. Table 1 provides the contextualized definitions of key constructs in the present study.

Table 1: Contextualized definitions of the key constructs in the study.

Variable	Definition
Core variable	
Perceived ease of use	The extent to which CFL learners perceive that little effort will be required to use ChatGPT.
Perceived usefulness	The extent to which CFL learners perceive that ChatGPT will be very useful and facilitate their Chinese learning.
Outcome variable	
Behavioral intention	The extent to which CFL learners intend to use ChatGPT for Chinese learning.
Environmental-level variable	
Facilitating conditions	The extent to which CFL learners perceive that factors and resources support their ChatGPT use, such as the technical and pedagogical support from classmates, teachers and schools.
Individual-level variable	
Growth mindset	The extent to which CFL learners perceive that ability to leverage ChatGPT is malleable and can be developed through effort.

Since the single quantitative method could not elicit richer and more accurate information on latent variables and the statistical model (Teng, Yuan, and Sun 2020), this study adopted a mixed-method approach to explore what motivates CFL learners' intention to use ChatGPT for Chinese language learning and their perceptions of ChatGPT-assisted Chinese learning. In this context, two research questions were formulated:

- (1) What factors contribute to CFL learners' behavioral intention to use ChatGPT for Chinese learning?
- (2) What are CFL learners' perceptions of using ChatGPT for Chinese learning?

2.3 Research Framework and Hypotheses

From the previous literature, based on TAM (Davis 1989), it is expected that CFL learners' behavioral intention to use ChatGPT is jointly determined by their perceived usefulness and perceived ease of use. These two perceptions were shown to positively predict behavioral intention to support mobile-assisted learning (Ebadi and Raygan 2023). Similarly, among Jordanian students, these two perceptions were found to significantly correlate with intention to use ChatGPT (Alshurideh et al. 2024). Furthermore, perceived ease of use was found to have an indirect effect on behavioral intention to use ChatGPT through the mediation of perceived usefulness (Liu, Darvin, and Ma 2024). In this way, the hypothesis can be summarized as follows.

H1: Perceived usefulness positively and directly influences CFL learners' behavioral intention to use ChatGPT.

H2: Perceived ease of use positively and directly influences CFL learners' behavioral intention to use ChatGPT.

H3: Perceived ease of use positively and directly influences CFL learners' perceived usefulness of ChatGPT.

Guided by social cognitive theory (Bandura 1986), factors, including environmental variables, such as facilitating conditions, and individual-level variables, such as growth mindset, may influence CFL learners' use of ChatGPT through the mediation of perceived usefulness and perceived ease of use. Nevertheless, inconsistent results on the role of facilitating conditions have been reported by prior research. In Sun and Mei (2020)'s research, facilitating conditions had no significant connection with behavioral intention to use technology among CFL teachers. Similarly, employing a mixed-method design Foroughi et al. (2023), also unearthed that there

was no significant association between facilitating conditions and intention to use ChatGPT among students in Malaysia. In contrast, among EFL teachers, facilitating conditions were found to foster positive perceptions of how easy the use of technology and potential adoption of technology (Bai, Wang, and Chai 2021; Huang, Teo, and Zhao 2023). In this context, future studies that look at its potential indirect impact through perceptions have been urged by researchers (Bai, Wang, and Chai 2021). Thus, we proposed the following:

H4: Facilitating conditions positively and directly influence CFL learners’ perceived ease of use of ChatGPT.

H5: Facilitating conditions positively and directly influence CFL learners’ behavioral intention to use ChatGPT.

Prior studies indicated growth mindset was positively related to behavioral intention to use ICT technology among language teachers (Bai, Wang, and Chai 2021; Xie et al. 2023). In addition, according to the theory of planned behavior, one’s belief about ability will impact his perceived control of behavior (Ajzen 1991), which is similar to the construct of perceived ease of use, and ultimately influences behavioral intention to use technology. Thus, the following hypotheses were proposed:

H6: Growth mindset positively and directly influences CFL learners’ perceived ease of use of ChatGPT.

H7: Growth mindset positively and directly influences CFL learners’ behavioral intention to use ChatGPT.

Building on the seven hypotheses, the conceptual model showcasing the inter-factor relationships among key variables in the present research can be seen in Figure 2.

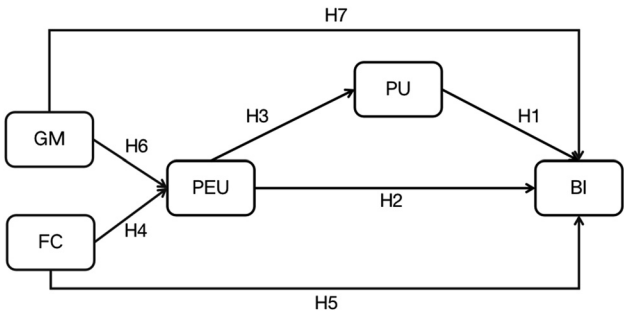


Figure 2: Conceptual framework in the present study. Notes: PU: perceived usefulness; PEU: perceived ease of use; BI: behavioral intention to use ChatGPT; FC: facilitating conditions; GM: growth mindset.

3 Methods

3.1 Participants

Participants were 120 international students (female, 65.00 %) enrolled in undergraduate or postgraduate programs in universities in China. The vast majority of them were from Asia and Africa, with a small number from Europe and North America, South America, and Oceania. They all spoke languages other than Chinese as their mother tongue with varied years of learning Chinese and HSK levels (standard test indicating L2 Chinese proficiency). Meanwhile, they had all learned English and could communicate in English easily. More background information can be seen in Table 2.

Table 2: Demographic information of respondents ($n = 120$).

Variable		Frequency	Percentage
Gender	Male	42	35.00 %
	Female	78	65.00 %
Age	<18	1	0.83 %
	18–24	91	75.83 %
	>24	28	23.33 %
Grade	Freshman	32	26.67 %
	Sophomore	16	13.33 %
	Junior	13	10.83 %
	Senior	24	20.00 %
Nationality	Master	35	29.17 %
	Asia	58	48.33 %
	Africa	25	20.83 %
	Europe	14	11.67 %
	North America	11	9.17 %
	South America	10	8.33 %
	Oceania	2	1.67 %
Years of learning Chinese	Less than 6 months	18	15.00 %
	6 months to 1 years	32	26.67 %
	1 years to 2 years	15	12.50 %
	2 years to 3 years	10	8.33 %
	More than 3 years	45	37.50 %
HSK level	HSK 1-2	8	6.67 %
	HSK 3	14	11.67 %
	HSK 4	22	18.33 %
	HSK 5	27	22.50 %
	HSK 6	29	24.17 %
	Not taken HSK exam yet	13	10.83 %
Total		120	100.00 %

3.2 Instruments

A three-part questionnaire presented in both Chinese and English was administered to CFL students to collect quantitative and qualitative data. Part 1 included demographical items, including gender, age, nationality, grade, years of learning Chinese, and HSK levels. Part 2 gathered students' self-reported perceptions of ChatGPT technology. This section integrated three TAM subscales adapted from Davis (1989), namely perceived usefulness (4 items), perceived ease of use (4 items), behavioral intention (3 items), and two scales, facilitating conditions (4 items) and growth mindset (3 items) drawn from Bai, Wang, and Chai (2021). All items were modified to focus on ChatGPT use and fit the context of CFL learning. A pool of 18 items was rated on a 7-point Likert scale, ranging from 'strongly disagree' to 'strongly agree'. More information on constructs and items can be found in Table 3. In Part 3, participants were asked to respond to an open-ended question: "When using ChatGPT technology for Chinese learning, I also have the following feelings or suggestions...". This section eliciting in-depth opinions on ChatGPT technology was designed to answer the second research questions, complementing, explaining, and triangulating quantitative results.

3.3 Data Collection and Analysis

Before data collection, permission was sought from the school ethics committee and teachers. Double-checked in terms of content validity by the three authors, the questionnaire was first piloted among 45 international students to ensure that the content could be accurately understood. Then the questionnaire was formally administered to potential volunteers via an online platform in the form of an e-poster with a QR code. In the introductory part of the questionnaire, participants were made aware of the purpose of the study and their right of withdrawal. Meanwhile, the gathered data was assured to remain entirely anonymous and to be kept strictly confidential. Finally, 120 valid answers without anomaly responses (3 responses with the same answers throughout the questionnaire) were gathered for subsequent quantitative analysis. 72 open-ended responses were collected for subsequent qualitative analysis after removing 48 blank records and answers with little information, such as "no" and ".".

For quantitative analysis, partial least squares structural equation modeling (PLS-SEM) by SmartPLS 3.0 software was used to gauge the measurement and structural models. It is a reliable analytic approach for complex model relationships estimation and theory extension based on a relatively limited sample size or non-normal data (Hair and Alamer 2022). First, the measurement model was assessed to

Table 3: Scales adapted and used in the study.

Construct	Item	English	Chinese
PU	PU1	GPT technology helps improve the quality of my Chinese learning.	GPT科技能帮助我提高中文学习质量。
	PU2	GPT technology helps me learn Chinese more efficiently.	GPT科技能帮助我增进中文学习效率。
	PU3	GPT technology brings more opportunities to learning Chinese.	GPT科技可以给我带来更多学习中文的机会。
	PU4	GPT technology benefits my Chinese learning.	GPT科技有益于我的中文学习。
PEU	PEU1	Using GPT technology is easy for me.	对我来说，GPT科技使用起来很方便。
	PEU2	Learning to operate GPT technology is easy for me.	对我来说，学习操作GPT科技很简单。
	PEU3	Becoming skillful in using GPT technology is easy for me.	对我来说，熟练使用GPT科技很容易。
	PEU4	Understanding what GPT technology provides is easy for me.	对我来说，理解GPT科技提供的内容很轻松。
BI	BI1	I am willing to spend time and effort to learn to use GPT technology better.	我愿意花时间和精力来更好地学习使用GPT科技。
	BI2	I expect to use GPT technology to learn more often in the future.	我预计以后会常使用GPT科技来学习。
	BI3	I plan to use GPT technology to learn Chinese in the future.	我计划将来会使用GPT科技来学习中文。
FC	FC1	When I have difficulties of using GPT technology, I have resorts for help.	当我在GPT科技使用上有困难时，我有求助的渠道。
	FC2	My teachers or classmates share useful GPT tools.	我的同学或老师分享有用的GPT工具。
	FC3	My teachers or classmates share stories of successful GPT use for Chinese learning.	我的同学或老师分享使用GPT科技促进中文学习的经历。
	FC4	My learning environment supports the use of GPT technology.	我所在的学习环境支持使用GPT科技。
GM	GM1	I can learn a lot from my mistakes in using GPT technology.	在使用GPT科技时，我可以从错误中收获很多。
	GM2	I like to challenge myself in using GPT technology.	在使用GPT科技时，我喜欢挑战自我。
	GM3	I can improve using GPT technology by paying more efforts.	我可以通过付出更多的努力来提高GPT科技使用技能。

PU, perceived usefulness; PEU, perceived ease of use; BI, behavioral intention; FC, facilitating conditions; GM, growth mindset.

ensure the reliability and validity of the measures. Second, the structural model was generated to examine the relationships among the studied variables. Specific reference benchmarks used to gauge the two models were summarized in Appendix Table A1.

For qualitative data, bottom-up inductive thematic analysis was conducted by the authors following six steps developed by Neuendorf (2018). It mainly involves (1) familiarization: read through responses multiple times to gain a comprehensive and deep understanding of the data; (2) initial coding: identify and label meaningful units to capture the essence of information; (3) theme searching: identify initial themes and patterns for further development; (4) theme reviewing: re-examine and extract the initial themes to ensure their accuracy and representation; (5) theme defining: refine, define and name the final themes to reflect their content; and (6) reporting: present the key findings with typical quotes to support the final themes.

Thus, the combined qualitative and quantitative data not only complemented each other but also provided a more multidimensional and complex understanding of CFL learners' perceptions of Chat GPT adoption for Chinese language learning.

4 Results

4.1 Quantitative Results

4.1.1 Measurement Model Evaluation

The measurement model was assessed to ensure indicator reliability, convergent validity, and discriminant validity. Parameters, including item loadings, Cronbach's alpha (α) and composite reliability (CR) were calculated to test the reliability. Average variance extracted (AVE) was employed to assess convergent validity. Heterotrait-monotrait (HTMT) values and Fornell-Larcker criterion was adopted to ensure discriminant validity. Additionally, we employed the full collinearity test to confirm the model was free of common method bias (Kock 2015).

As Table 4 indicates, all loadings of the items exceeded the suggested value of 0.7 and all Cronbach's α values of variables were greater than 0.7, which confirmed their internal consistency reliability. Furthermore, AVE and CR values for all constructs were satisfactory, with the former reaching 0.5 and the latter in excess of 0.7 (Mohammadi, Saeidi, and Abdollahi 2023). In addition, discriminant validity was ensured by meeting the Fornell-Larcker criterion that the square root of each variable's AVEs should be larger than the estimated correlation with the other variable (see Table 5). As Table 6 shows, HTMT values were all less than 0.9, which confirmed that discriminant validity was acceptable (Hair and Alamer 2022). Finally, according to Kock (2015), in the context of PLS-SEM, no occurrence of VIF values of latent variables over 3.3 suggests no common method bias issue. Our results met the above requirement with VIFs ranging from 1.0 to 2.7, which suggests common method bias is not a concern in this study.

Table 4: Evaluation of the measurement model.

Variable	Item	Loading	α	CR	AVE
PU	PU1	0.928	0.961	0.972	0.896
	PU2	0.957			
	PU3	0.953			
	PU4	0.948			
PEU	PEU1	0.931	0.944	0.960	0.856
	PEU2	0.948			
	PEU3	0.918			
	PEU4	0.903			
BI	BI1	0.920	0.912	0.945	0.850
	BI2	0.929			
	BI3	0.917			
FC	FC1	0.836	0.927	0.948	0.821
	FC2	0.935			
	FC3	0.904			
	FC4	0.945			
GM	GM1	0.929	0.895	0.934	0.826
	GM2	0.883			
	GM3	0.913			

Reliability indicators include loading, Cronbach’s alpha (α) and composite reliability; convergent validity indicator includes average variance extracted; PU, perceived usefulness; PEU, perceived ease of use; BI, behavioral intention to use ChatGPT; FC, facilitating conditions; GM, growth mindset.

Table 5: Model’s discriminant validity by Fornell-Larcker Criterion.

	PU	PEU	FC	GM	BI
1.PU	0.946				
2.PEU	0.664	0.925			
3.FC	0.628	0.497	0.906		
4.GM	0.729	0.640	0.665	0.909	
5.BI	0.746	0.619	0.657	0.788	0.922

PU, perceived usefulness; PEU, perceived ease of use; BI, behavioral intention to use ChatGPT; FC, facilitating conditions; GM, growth mindset. Bold values represent the square root of the AVE for each construct.

Table 6: Model’s discriminant validity by HTMT values.

	PU	PEU	FC	GM	BI
PU					
PEU	0.697				
FC	0.663	0.531			
GM	0.782	0.692	0.726		
BI	0.794	0.664	0.712	0.864	

HTMT, heterotrait-monotrait; PU, perceived usefulness; PEU, perceived ease of use; BI, behavioral intention to use ChatGPT; FC, facilitating conditions; GM, growth mindset.

4.1.2 Structural Model Evaluation

The structural model was assessed to test the study’s proposed hypotheses based on TAM and social cognitive theory and literature reviewed. According to the explanatory power indicator, R^2 , the suggested model explained 70.0 % of the variation in behavioral intention to use ChatGPT. According to Hair and Alamer (2022), due to the predictive nature of PLS-SEM, model fit indices may have limited value when the main goal is to understand variable relationships and effects. That said, we still checked the model fitness through standardized root mean squared residual (SRMR). The SRMR value of study was 0.046, which is less than the suggested level of 0.08 (Hu and Bentler 1999). Thus, the model fitness can be deemed as acceptable.

Based on the bootstrapping results presented in Table 7, we found that five out of the seven proposed hypotheses were supported, while two were rejected. Specifically, the results indicate that perceived usefulness significantly predicted behavioral intention to use ChatGPT (Hypothesis 1 accepted), suggesting that individuals who perceive ChatGPT as useful are more likely to intend to use it. Additionally, perceived ease of use significantly predicted perceived usefulness (Hypothesis 3 accepted), implying that when individuals find ChatGPT easy to use, they are more likely to see it as beneficial.

However, we found an insignificant relationship between perceived ease of use and behavioral intention to use ChatGPT (Hypothesis 2 rejected), indicating that ease of use alone may not directly influence the intention to engage with ChatGPT. Furthermore, facilitating conditions significantly predicted behavioral intention to use ChatGPT (Hypothesis 5 accepted) but did not have a significant impact on perceived ease of use (Hypothesis 4 rejected). This suggests that while adequate support and resources can enhance an individual’s intention to use ChatGPT, they do not necessarily affect how easy the individual finds it to use.

Lastly, growth mindset significantly predicted both perceived ease of use (Hypothesis 6 accepted) and behavioral intention to use ChatGPT (Hypothesis 7 accepted). This indicates that individuals with a growth mindset, who believe in their

Table 7: Hypothesized path significance and coefficients.

Hypothesis	Path	β	p	Results
H1	PU - > BI	0.285	0.007	Accepted
H2	PEU - > BI	0.082	0.346	Rejected
H3	PEU - > PU	0.664	0.000	Accepted
H4	FC- > PEU	0.129	0.205	Rejected
H5	FC - > BI	0.156	0.041	Accepted
H6	GM - > PEU	0.554	0.000	Accepted
H7	GM - > BI	0.424	0.000	Accepted

Path significance indicator: p values and standardized path coefficient, β . PU, perceived usefulness; PEU, perceived ease of use; BI, behavioral intention to use ChatGPT; FC, facilitating conditions; GM, growth mindset.

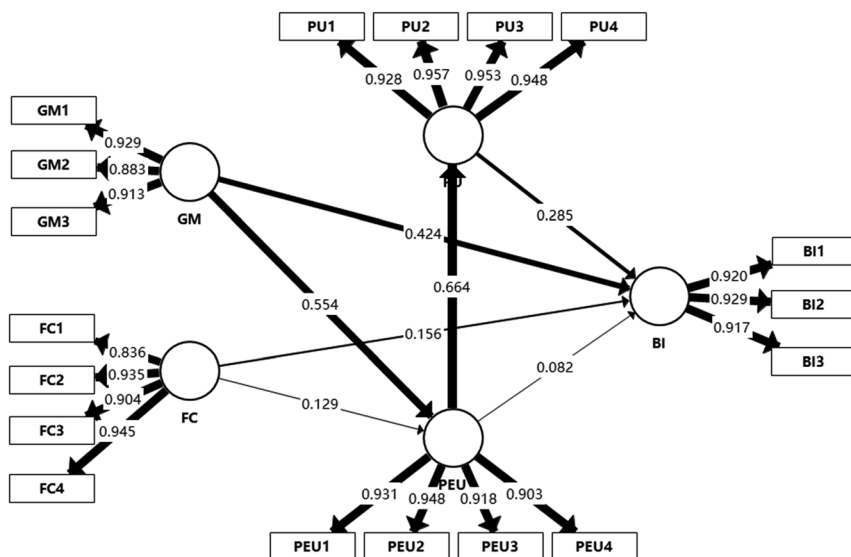


Figure 3: The final established model. Notes: PU: perceived usefulness; PEU: perceived ease of use; BI: behavioral intention to use ChatGPT; FC: facilitating conditions; GM: growth mindset.

ability to learn and adapt, are more likely to find ChatGPT easy to use and intend to use it actively. The final established model is presented in Figure 3.

4.2 Qualitative Results

Three themes with eleven sub-themes emerged from the open-ended responses through thematic analysis and the specifics and frequencies are presented in Table 8. A word cloud Figure 4 was created by a free online word cloud generator, WordArt.com, to depict comments most commonly used by the respondents according to their frequencies.

Three major themes emerge from the discussion: positivity, negativity, and suggestions for utilizing ChatGPT in Chinese language learning. Positivity pertains to the favorable feedback provided by students regarding their experiences with ChatGPT, which can be categorized into three distinct types. First, appreciation and optimism: these comments, the most frequently cited, were articulated by students who received substantial assistance from ChatGPT and regarded the tool as both useful and powerful. Emotionally, students expressed enthusiasm and optimism about the future of this technology, acknowledging its potential to revolutionize the educational landscape. For instance, one respondent stated, “ChatGPT is amazing for

Table 8: The frequency and content of three themes and their subthemes.

Theme	Subtheme	Frequency
Positivity	Appreciation & optimism	24
	User-friendliness & efficiency	12
	Personalized learning & diverse resources	7
Negativity	Answer inaccuracy & unintelligence	13
	Uncertainty & overdependence	9
	Difficult access & use	8
	Monotonous output	7
Suggestions	More intelligent & understandable	13
	More abundant & interactive	7
	More instruction	6
	More rules	2



Figure 4: The word cloud of respondents' comments.

Chinese learning. I feel like ChatGPT is not only my Chinese learning partner but also my future ambition partner.” Secondly, user-friendliness & efficiency: the theme elucidates specific reasons for the high evaluations of ChatGPT among students. It has been recognized that this tool can be employed by anyone, anywhere, due to its intuitive design and rapid response capabilities. Through constructive feedback, students can enhance their Chinese learning efficiency and achieve their optimal goals. As one learner noted, “ChatGPT makes it easier and efficient for me to learn Chinese on my own.” Thirdly, personalized learning & diverse resources: some students reported that ChatGPT can provide tailored guidance and feedback.

catering to their individual learning styles and needs. This tool is particularly beneficial for language learners with varying levels of proficiency, enabling them to practice both oral and written skills. Additionally, some participants indicated that “ChatGPT provides a wide range of supplementary learning materials”, which helped them familiarize distinctive background knowledge and enhance their cultural understanding. Furthermore, some students remarked that using ChatGPT for self-study is more advantageous than traditional instruction in the classroom setting.

Negativity reflects comments mirroring students’ unfavorable perceptions of ChatGPT. The theme of “answer inaccuracy and lack of intelligence” highlights concerns among some participants who expressed that the tool is not sufficiently intelligent, and that its answers lack precision, naturalness, and specificity. For instance, one learner remarked, “Its answers are too rigid.” The theme of “uncertainty & overdependence” revealed that a few students maintained that students cautioned against excessive reliance on ChatGPT, emphasizing that it should be used judiciously. Notably, some held entirely negative attitudes towards this technology, asserting that “Using ChatGPT is 100 % uncomfortable for learning Chinese, because ChatGPT will make student lazy.” A respondent shared his personal experience, expressing concerns that ChatGPT fosters laziness among students, ultimately hindering their Chinese learning. He stated, “The more I use ChatGPT, the more I rely on it. I won’t study for writing Chinese characters, thesis, and simple sentences.” In terms of the theme of “difficult access & use”, there are also comments mentioning the difficulties of navigating the system, such as generating suitable prompts and understanding the answers. For example, as a learner noted, “I can’t understand the Chinese essay ChatGPT revised for me.” Meanwhile, they had limited access to this tool which was unavailable in some settings. As to the theme of “monotonous output”: some respondents mentioned that ChatGPT lacks colorful multimedia output, lively interaction, and cultural awareness. One informant put it: “What ChatGPT produces are all words. I prefer human-to-human interaction better.”

In light of the drawbacks of ChatGPT, students also offered their constructive suggestions to improve user experience for better Chinese learning outcomes. The theme of “more intelligent & understandable” revealed that as far as the technology is concerned, respondents believe that engineers should endeavor to improve the algorithms so that they can provide more fluent, understandable, specific, and targeted feedback. The majority of comments suggested that “ChatGPT can be easier and more understandable.” The theme of “more abundant & interactive” showed that ChatGPT needs to enrich forms of content output, such as video and picture, combined with specific cultural background knowledge. Furthermore, customized and interactive services should be implemented to enhance human-computer interaction. For example, a participant said: “It would be helpful to have more interactive exercises to reinforce learning. Additionally, incorporating real-life

scenarios or cultural insights can enhance language comprehension and practical application.” The theme of “more instruction” reflects students’ comments indicating that educators should broaden the use of GPT and provide more relevant case studies of GPT-assisted Chinese learning. This would demonstrate how to use appropriate prompts and understand the output effectively. One response included: “Encourage and teach how to practice Chinese listening and grammar.” Finally, the theme of “more rules” suggests that a few participants supposed that appropriate scenarios for using ChatGPT should be specified to prevent misuse and over-reliance.

5 Discussion

This mixed-method study examined CFL learners’ perceptions and adoption of ChatGPT technology for Chinese learning by integrating social cognitive theory into TAM. While the quantitative results measured what factors contribute to CFL learners’ desire to use ChatGPT for Chinese language learning, the qualitative results enriched our understanding by providing a more nuanced perspective on their perceptions of this technology.

5.1 Drivers of Using ChatGPT

The quantitative findings established a structural model based on TAM and SCT that accounts for 70 % of the total variance in CFL learners’ behavioral intention to use ChatGPT to learn Chinese. Lending support to previous TAM literature (Liu, Darwin, and Ma 2024), this study confirms that perceived usefulness was positively associated with CFL learners’ behavioral intention to use ChatGPT technology. This finding suggests if a learner believes that ChatGPT is valuable for learning Chinese, they would be inclined to leverage it. As AI technology with a powerful text generation capability can facilitate teaching and learning, and even reshape the educational ecosystem (Hadi Mogavi et al. 2024), it is understandable that CFL learners would hold a positive attitude towards ChatGPT’s value, which would eventually lead them to adopt this technology. Meanwhile, perceived ease of use of the new technology was positively tied to perceived usefulness, which confirms the strong and significant effect reported in previous research conducted among language teachers (Teo and Huang 2018) and EFL learners (Liu and Ma 2023). This implies that the less difficult the student feels it is to use ChatGPT, the more he will feel the value of the technology.

In contrast to our hypothesis, perceived ease of use failed to predict students’ behavioral intention, which corresponds with Liu, Darwin, and Ma (2024)’s research. One tenable explanation, as suggested by qualitative findings may be that students

may find it challenging to interact with the system effectively due to a lack of adequate skills for generating appropriate prompts and critical thinking for evaluating the answers. This perceived incompetence of AI-powered technology is likely to decrease willingness to use it. Another potential reason for the absence of a significant direct effect might stem from perceived usefulness serves as a full mediator between perceived ease of use and behavioral intention (Liu, Darwin, and Ma 2024). That is to say, the single perception of the easy operation of ChatGPT could not contribute to CFL learner's willingness to use it, but it could affect their belief in the value of the technology, which will eventually predict students' behavior intention to use Chat GPT for language learning purposes.

Inspired by social cognitive theory, two specific environmental and individual-level variables, namely facilitating conditions and growth mindset, were added to the TAM. First, facilitating conditions, as hypothesized, had a positive impact on behavioral intention. This outcome suggests that the availability of technical support and supportive resources in the surrounding environment plays a crucial role in enhancing CFL students' willingness to engage with ChatGPT. The presence of facilitating conditions can include aspects such as access to reliable technology, availability of support from classmates, teachers, and schools, and an encouraging learning environment, which collectively contribute to a greater likelihood of adopting new technologies.

However, the positive relationship between facilitating conditions and behavioral intention stands in contrast to some previous research findings (Foroughi et al. 2023; Huang, Teo, and Zhao 2023; Sun and Mei 2020). This discrepancy may be justified by different sample groups targeted in the research. While most studies focused on teachers and EFL learners, the present study attempted to examine potential drivers for CFL learners' use of ChatGPT tools. This result highlights the need for schools to remove barriers to learners' ChatGPT usage and to support their ChatGPT-assisted learning by offering pedagogical and technological resources.

An unsupported path from facilitating conditions to perceived ease of use unveiled is inconsistent with extant literature (Bai, Wang, and Chai 2021; Teo, Huang, and Hoi 2017). This finding may be explained by the fact that students had limited access to ChatGPT, since this technology was officially unavailable in certain contexts (Liu, Darwin, and Ma 2024). As they mentioned in the open-ended part, another reason may be that CFL learners received little instruction on how to generate appropriate prompts and how to evaluate Chatbots' feedback, which may reduce their perceived ease of use of this technology.

Emphasizing learners' initiative, this study provides new insight into the domain-specific role of growth mindset, which adds credit to the explanatory power of the TAM. First, as a motivational belief, growth mindset directly contributed to students' perceived competence of ChatGPT usage. This finding supports the theory

of planned behavior (Ajzen 1991) that emphasizes the role of “salient belief” in influencing behavior and should be taken into account when considering how to enhance students’ confidence in using this technology effectively in the face of possible problems.

Additionally, growth mindset was identified as a direct and positive predictor of students’ behavioral intention to use ChatGPT, which chimes with earlier research conducted among language teachers (Xie et al. 2023). Whereas the construct has received increasing attention in motivational research, few studies have investigated its contextualized role in technology acceptance research. In addition to environmental factors, this study emphasizes the influence of learners’ subjective mindsets on their behavioral adoption of technological tools, which echoes the core tenet of social cognitive theory (Bandura 1999) and a call to focus on the role of learner-internal factors (Li 2024). In today’s fast-paced, ever-evolving digital landscape, it is advisable to embrace positive attitudinal beliefs in learning to use new technology and actively seek solutions to problems encountered (Bai, Wang, and Chai 2021). By fostering a growth mindset, individuals can not only develop a positive approach to learning new technologies, but also ultimately support their lifelong learning journey (Sheffler et al. 2023).

5.2 Perceptions of Using ChatGPT

The qualitative data not only expand the interpretations of the quantitative results regarding the psychological drivers influencing CFL learners’ decision-making process related to ChatGPT adoption, but also illuminate their mixed views on this new technology. Three primary themes – namely, positivity, negativity, and suggestions – along with eleven sub-themes derived from thematic analysis, which are similar to the previous findings (Abdulhadi 2023; Cai, Lin, and Yu 2023). These findings emphasize the potential benefits and challenges associated with integrating AI tools into language teaching and learning.

First, three sub-themes were gleaned from students’ favorable perspectives on ChatGPT, including general positive feelings towards ChatGPT, user-friendly and efficient system design, and customized and abundant user experience. On the whole, most respondents perceived this technology as a valuable and promising tool assisting Chinese learning. They were interested, motivated, and optimistic about this attractive platform, which is conducive to language learning productivity and efficiency. Their positive comments are often attributed to ChatGPT’s capability to provide fast and understandable feedback as well as personalized instruction and resources. These findings are in accord with a recent large-scale study (Hadi Mogavi et al. 2024) indicating that individuals express positive opinions

regarding the utility of ChatGPT in educational domains by and large. The study revealed that this ChatGPT is especially instrumental in improving language skills and enhancing confidence and fluency for students in primary and secondary education. Furthermore, tailored and adaptive learning provided by the system can adjust to each student's learning pace and style.

Second, four types of negative opinions on ChatGPT were identified among CFL learners, encompassing its inaccuracy, overreliance, usage difficulty, and monotonous output. These findings generally align with Abdulhadi (2023). Students' concerns partially echo those expressed by parents and teachers, who worry that excessive use of ChatGPT will exacerbate procrastination, impede knowledge application, and diminish interaction (Hadi Mogavi et al. 2024). According to Self-Determination Theory, on condition that people feel competent, related, and in control of their actions, they will become more engaged and driven (Deci and Ryan 2012). Thus, if ChatGPT takes on much of the responsibility of language learning, students may feel less competence and autonomy, which may weaken their motivation, engagement, and performance.

Thirdly, participants were also invited to share their recommendations for optimal utilization of ChatGPT to facilitate Chinese learning. These suggestions can be categorized into four types, including more intelligent & understandable, more abundant & interactive, more instruction, and more rules. Given that the participants in this study were early adopters of GPT technology, it is likely that the GPT-4 technology was not yet in widespread use. As we mentioned before, the latest GPT-4 is already capable of generating dynamic images and videos on suitable prompts. It can be expected that the technology will continue to be upgraded to provide more abundant content and more interactive user experience. Furthermore, AI-supported self-directed learning not only saves time and effort but also is personalized and adaptive to students' needs. There would seem to be a definite need for schools and teachers to develop students' abilities to interact with ChatGPT (Firat 2023). A series of structural pedagogical courses on effective prompts and critical thinking development should be provided to enhance AI-assisted Chinese learning. Additionally, specific and well-defined guidelines on when and why to use this tool should be established to minimize the potential risks of academic misconduct and excessive dependence (Hadi Mogavi et al. 2024). According to the Theory of Planned Behavior (Ajzen 1991), an individual's behavior is determined by corresponding attitude, subjective norms, and perceived behavioral control. Thereby, clear and well-reasoned rules regarding the use of ChatGPT can contribute to learners' responsible and effective utilization of this tool, ultimately maximizing the benefits of AI integration in CFL language education.

6 Conclusions

Drawing on TAM and social cognitive theory, the present mixed-method study examined CFL learners' perceptions and acceptance of ChatGPT for Chinese language learning. The quantitative model established in the study expands the applicability of the original TAM by specifying the specific environmental and individual-level variables. The results indicate that perceived usefulness, facilitating conditions, and growth mindset significantly predict behavioral intention to use ChatGPT, while perceived ease of use does not have a significant direct effect on behavioral intention. The qualitative data not only help interpret and triangulate the quantitative results but also reveal various nuanced views of this AI technology among CFL learners. From inductive thematic analysis, three themes and 11 sub-themes emerge. As CFL students increasingly become key players in the rapidly evolving educational landscape (Gong, Lai, and Gao 2020), understanding their perceptions of the AI tool is highly relevant for effectively integrating AI into L2 Chinese education to enhance their learning engagement, motivation, and outcomes.

Despite these valuable insights, this study has several limitations. First, the limited sample size of 120 CFL learners may restrict the generalizability of the results. A more comprehensive grasp of the ChatGPT acceptance and perceptions can be obtained by including more individuals from varied backgrounds and nations. Second, demographic variables, such as gender and grade, were not incorporated into the model. Future research can consider the possible moderating role of these variables to fully understand differences between groups (Abdulhadi 2023). Thirdly, the data collected are cross-sectional. Researchers can conduct longitudinal and in-depth research to capture dynamic attitudinal shifts among CFL learners as AI technology becomes more prevalent in the future.

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Appendix

Table A1: The reference criteria for evaluating the SEM models.

Model	Evaluation	Benchmarks	Results
The measurement model	Reliability	Item loadings > 0.70	Acceptable
		Cronbach's α > 0.70	Acceptable
	Convergence validity	CR > 0.70	Acceptable
		AVE > 0.50	Acceptable
	Discriminant validity	HTMT < 0.85	Acceptable
The structural model		Square root of AVEs > Covariances	Acceptable
	Multicollinearity	VIF < 10.00	Acceptable
	Explanatory degree	$0.26 < R^2 \leq 1.00$	Strong
		$0.13 < R^2 \leq 0.26$	Moderate
		$0.02 < R^2 \leq 0.13$	Poor
	Predictive accuracy	$Q^2 > 0$	Acceptable
	Model fitness	$0.36 < \text{GoF} \leq 1.00$	Strong
		$0.25 < \text{GoF} \leq 36$	Moderate
		$0.10 < \text{GoF} \leq 0.25$	Poor
	Bootstrapping results	Path significance	T values > 1.96
			P values < 0.05
		Effect size	Significant
			Significant
			Strong
			Moderate
			Poor
		$0.35 \leq f^2 \leq 1.00$	Strong
		$0.15 \leq f^2 < 0.35$	Moderate
		$0.02 \leq f^2 < 0.15$	Poor

CR, composite reliability values; AVE, average variance extracted values; HTMT, heterotrait monotrait ratios; VIF, variance inflation factor; R^2 , coefficient of determination; Q^2 , the stone-geisser Q^2 values; GoF, goodness of fit; β , standardized path coefficient.

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