

Investigating AI-mediated informal digital learning of English (AI-IDLE): the adoption and experiences of Chinese EFL learners with DeepSeek

Zhang Yuan

Educational Sciences and Technology, Universiti Teknologi Malaysia

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ABSTRACT

This study investigates Chinese EFL learners' adoption and experiences of AI-mediated Informal Digital Learning of English (AI-IDLE) using DeepSeek. Employing an explanatory sequential mixed-methods design, the research integrates the Technology Acceptance Model (TAM) to analyze learners' perceptions of DeepSeek's usefulness, ease of use, and actual utilization in autonomous language learning. Quantitative survey data (N=60) revealed high engagement with AI for receptive (e.g., curating learning resources) and productive (e.g., grammar feedback, conversation practice) IDLE activities. Qualitative interviews (n=20) highlighted two primary AI functions—tutoring and conversational partnering. Findings suggest DeepSeek enhances autonomous learning but requires pedagogical integration to maximize its potential.

INTRODUCTION

In the field of Computer-Assisted Language Learning (CALL), scholars have increasingly examined how leisure-oriented digital activities—such as gaming, video streaming, and fan fiction writing—support second language (L2) acquisition beyond formal classrooms. These practices have been conceptualized using various frameworks, including recreational language learning (Chik & Ho, 2017), extramural English (Sundqvist & Sylvén, 2016), the digital wilds (Sauro & Zourou, 2019), and most recently, Informal Digital Learning of English (IDLE) (Lee & Lee, 2021). IDLE highlights self-initiated, interest-driven English learning in digital spaces, independent of formal assessment. Research across diverse regions—including China, South Korea, Sweden, Saudi Arabia, and Kazakhstan—has demonstrated that IDLE fosters linguistic development and socio-emotional engagement (Lee & Dressman, 2018; Liu et al., 2023; Zadorozhnyy & Lee, 2023). As digital environments continue to evolve, understanding how L2 learners leverage emergent technologies to navigate informal learning remains a dynamic and essential area for ongoing CALL research (Soyoof et al., 2023; Zhang & Liu, 2022).

According to Bill Gates (2023), recent advances in natural language processing and large language models have ushered in the age of Artificial Intelligence (AI). Since late 2022, tools like ChatGPT and DeepSeek have enabled second language (L2) learners to engage in more creative and adaptive informal language learning. These AI chatbots, built on vast web-based corpora, demonstrate strong linguistic accuracy, contextual awareness, and the ability to recognize language varieties and cultural nuances (Tam, 2023). Notably, DeepSeek V3, released in December 2024, is a multimodal model capable of processing both text and visual input, enhanced by reinforcement learning and human-AI interaction data (Gates, 2023; Rudolph et al., 2023).

Research has shown that AI tools like ChatGPT and DeepSeek can improve language learning outcomes. ChatGPT fosters interactive dialogue and instant feedback, supporting personalized learning (Cai, 2023; Yan, 2023), while DeepSeek offers more accurate and contextually relevant feedback than earlier models (Zhang & Liu, 2025). Its chain-of-thought reasoning helps learners better understand their errors and supports long-term retention (Brown et al., 2024).

While the potential of AI chatbots for language learning is well recognized, limited research exists on learners' perceptions and effective use of DeepSeek for autonomous L2 English learning. Chun (2019) stresses the importance of aligning technological affordances with learners' goals. This study investigates how Chinese L2 learners use and perceive DeepSeek in informal contexts, contributing to the understanding of AI-mediated informal digital language learning (AI-IDLE) and informing future instructional approaches in the AI era.

LITERATURE REVIEW

This section provides an overview of how AI technologies can facilitate informal language learning by examining prior research on intelligent Computer-Assisted Language Learning (CALL) in both instructional and non-instructional settings, considering that AI-IDLE is a burgeoning field of study. It utilizes the Technology Acceptance Model (TAM) to model and implement the process by which language learners embrace DeepSeek technology for IDLE objectives.

Empirical Evidence on AI in Formal Language Learning

Recent research findings in formal language learning contexts indicate that AI technologies improve instruction, offer adaptive feedback, and facilitate differentiated learning. Chen et al. (2020) demonstrated that AI-based writing tools enhance students' academic writing accuracy and coherence in EFL classrooms. Zawacki-Richter et al. (2019) emphasized that AI-driven learning analytics facilitated the identification of struggling students and the personalization of support by educators. Liu and Wang (2023) found that the integration of chatbots in speaking activities enhanced learners' oral fluency and participation in the classroom. Lu et al. (2022) found that vocabulary applications enhanced by AI increased retention rates when integrated into curriculum-based tasks. Empirical evidence indicates that the integration of AI into formal instruction enhances learner engagement, provides immediate feedback, and results in measurable linguistic improvements.

Empirical Evidence on AI in Informal Language Learning

In non-instructional contexts, tools such as chatbots, intelligent feedback systems, and generative models (e.g., DeepSeek, ChatGPT) can effectively support informal second language (L2) learning by promoting learner autonomy, motivation, and language development. Reinders and Benson (2017) and Xu and Reinders (2020) demonstrated that AI-driven conversational agents and mobile applications enhance learners' fluency and grammatical accuracy via adaptive interaction and real-time feedback. Lee and Dressman (2018) demonstrated that intelligent tools facilitate vocabulary development and increase learning motivation in the context of Informal Digital Learning of English (IDLE) during out-of-class activities. Liu et al. (2023) demonstrated that university students utilizing AI writing assistants such as DeepSeek exhibited enhanced lexical and syntactic performance in informal writing tasks, highlighting the effectiveness of immediate, context-sensitive feedback. Soyoof et al. (2023) found that the use of AI tools in personalized, informal learning environments enhanced self-efficacy and engagement among learners. Previous literature has provided initial insights into the relationship between AI technologies and informal language learning; however, there is limited understanding of how informal L2 learners engage with and adapt to various applications of the latest AI technologies, which have shown the potential to learn or surpass human intelligence (Zhou et al., 2023).

This study examines the role of new chatbot technologies (DeepSeek) in enhancing L2 learners' engagement in IDLE activities, thereby addressing an existing research gap. This study aims to address a central question: How do L2 learners accept and integrate DeepSeek technologies in their informal digital learning of English?

Technology Acceptance Model framework

This study examines the acceptance and usage of DeepSeek technologies among L2 learners, utilizing Davis's (1989) Technology Acceptance Model framework to provide a theoretical basis for technology implementation and acceptance in information systems. The Technology Acceptance Model (TAM) suggests that users' adoption

of technology is determined by their intention to use it, which is influenced by their perceptions of the technology's usefulness for task completion and its ease of use (Davis, 1989). Numerous subsequent versions of the Technology Acceptance Model (TAM) have emerged, integrating external variables such as computer self-efficacy. However, the fundamental components of TAM remain Perceived Ease of Use, Perceived Usefulness, Intention to Use, and Actual Use, which together form the cognition-attitude-behavior causality (Al-Emran et al., 2018; Davis, 1989).

This framework is extensively utilized in educational research to elucidate learners' intentions regarding the adoption of digital tools, particularly within the context of second language acquisition. Recent studies have adopted the Technology Acceptance Model (TAM) to investigate learners' engagement with AI-driven language learning tools, including mobile dictionaries, language learning applications, and AI chatbots. Zhou and Wei (2022) demonstrated that both perceived usefulness (PU) and perceived ease of use (PEOU) significantly predicted the willingness of Chinese EFL learners to utilize AI-powered mobile applications for vocabulary acquisition. Alamer and Alrabai (2021) indicated that learners' behavioral intentions to utilize AI tools were influenced by motivational factors, including perceived autonomy and competence.

Although widely utilized, limited research has specifically employed the Technology Acceptance Model (TAM) to investigate learners' perceptions of advanced multimodal AI models such as DeepSeek in informal learning environments. Integrating TAM into this study provides a solid framework for evaluating how L2 learners perceive DeepSeek's affordances for personalized and autonomous English learning beyond the classroom.

METHODOLOGY

This research employed an explanatory sequential mixed-method design, in which the quantitative stage informs the qualitative stage (Creswell & Clark, 2011). The numerical results were collected and analyzed via an online survey during the quantitative phase. The qualitative phase, informed by the survey results, included semi-structured interviews and a thematic analysis of the interview data (Creswell & Clark, 2011). The interview findings enhance the quantitative results by offering specific examples of EFL learners' acceptance and use of DeepSeek technologies for IDLE purposes.

This research was carried out within the framework of EFL instruction at Chinese universities. DeepSeek V3 was utilized as the AI tool in our study. DeepSeek V3 employs a mixture of experts (MoE) architecture featuring multi-head latent attention. Benchmark results indicate that it is comparable to GPT-4o and Claude 3.5 in code generation (HumanEval), general understanding (MMLU), and translation tasks, while also demonstrating notable cost efficiency.

We utilized purposive sampling to recruit questionnaire respondents by distributing the questionnaire link on Chinese social media platforms (QQ and WeChat groups) to undergraduate students at Chongqing University of Arts and Sciences. Participants in this study were individuals who self-identified as Chinese EFL learners and had engaged in over 50 hours of informal English learning utilizing DeepSeek technologies from late 2024 to May 2025. A total of 60 students were selected as participants, comprising 39 females and 21 males for the quantitative study. In the interviews, we selected 10 males and 10 females to participate. Their fields of study encompassed both English and non-English disciplines. All participants were in their second and third year of study.

Research Question

How do L2 learners accept and integrate DeepSeek technologies in their informal digital learning of English?

Data collection and analysis

Quantitative data and analysis

A modified TAM questionnaire was employed to gather quantitative data. The questionnaire began with demographic items employing a nominal scale to collect participant information regarding sex, age, past AI usage experiences, and specific types of AI technologies utilized. The following section included four subscales of the Technology Acceptance Model (TAM), which were modified from Davis (1989) and other relevant TAM instruments (e.g., Sun & Mei, 2022; Venkatesh, 2000). The four subscales comprised Perceived Ease of Use, Perceived Usefulness, Intention to Use, and Actual Use. To ensure the accuracy of items in the Actual Use subscale, we referenced IDLE literature (Lee & Draji, 2019; Lee & Lee, 2021; Liu & Ma, 2023) to create items that illustrate how participants independently employed DeepSeek technologies for English learning beyond the classroom. A six-point Likert scale ranging from 'strongly disagree' (1) to 'strongly agree' (6) was utilized to assess participants' perceptions and behaviors. The questionnaire was distributed through an online survey platform and accessed by participants via a QR code.

We run SPSS 26.0 for quantitative data analysis. Quantitative data obtained from the questionnaires were examined using descriptive statistical methods. The initial focus pertains to data cleaning. We conducted a screening of the data to identify multivariate outliers and irregularities by calculating the Mahalanobis distance, as well as the skewness and kurtosis values of the items. The findings demonstrated that the data exhibited symmetrical and normal distribution, making them suitable for subsequent analysis. Secondly, we performed descriptive analyses to produce clear insights regarding the items' means and standardized deviations.

Qualitative data and analysis

Thematic analysis was conducted (Braun & Clarke, 2021). The quantitative findings inform the qualitative analysis by highlighting themes that require additional investigation, such as the factors influencing perceived usefulness. Additionally, the survey results provided insights into EFL learners' acceptance of DeepSeek technologies through a substantial sample, while the semi-structured interviews yielded a more detailed and nuanced understanding of how participants navigated the adoption and utilization of AI in their IDLE activities. The qualitative findings not only supported the quantitative results but also offered a more nuanced and comprehensive understanding of AI-IDLE.

FINDINGS

This section provides essential quantitative findings that detail the frequency and variability of the TAM variables. Table 1 outlines the descriptive statistics (Means and Standard Deviations) for the key TAM variables, offering insights into both usage frequency and individual response variability. All items recorded mean scores above 3.75, suggesting that learners generally maintained favorable perceptions regarding the ease of use and perceived usefulness of AI technologies during informal English learning. A closer inspection of the table uncovers notable usage trends. For instance, learners often relied on AI tools to curate and synthesize English learning content from online sources (Q23, $M = 4.14$, $SD = 0.96$). Furthermore, many participants used AI-based proofreading to enhance their writing and reading skills outside formal classroom settings (Q16, $M = 4.11$, $SD = 0.93$). The use of AI to boost learners' confidence in English learning beyond academic environments was also common (Q24, $M = 4.09$, $SD = 0.94$).

Constructs	Items	M	SD
Perceived ease of use	Q6: I feel that DeepSeek technology is easy to use	3.75	0.90
	Q12: I think I can easily understand what DeepSeek provides	4.06	0.92
	Q21: I think it is easy to learn to use DeepSeek	3.97	0.89
	Q22: I think DeepSeek is easy to use	4.11	0.87
Perceived usefulness	Q5: I think DeepSeek can help me improve the quality of my English learning	4.25	1.02
	Q7: I think DeepSeek can help me learn English more effectively	4.27	0.98
	Q15: I think DeepSeek is useful in my extracurricular English learning	4.56	1.10
	Q17: I think DeepSeek can bring me more opportunities to learn English	4.49	0.97
	Q18: I think DeepSeek can help me improve my English language learning skills	4.52	0.99
Intention to use	Q13: I am willing to spend time and effort to learn to use DeepSeek better	4.13	0.88
	Q14: I expect to use DeepSeek to learn more often in the future	4.08	1.01
	Q21: I plan to use DeepSeek to learn English in the future	4.10	0.86
Actual use	Q8: I use DeepSeek to increase my interest and motivation in learning English	3.98	0.87
	Q10: I use DeepSeek to improve my English communication skills (such as using AI to simulate IELTS speaking practice)	4.03	1.06
	Q16: I use DeepSeek to improve my English reading and writing skills (e.g. proofreading)	4.11	0.93
	Q23: I use DeepSeek to collect and integrate online English learning information more efficiently	4.14	0.96
	Q24: I use DeepSeek to help me understand English language and culture more deeply	4.09	0.94
	Q26: I use DeepSeek to enhance my English learning confidence in and out of the classroom	4.01	0.90

Table 1. Descriptive statistics

The quantitative results assessed learners' perceptions of the usefulness and ease of use of DeepSeek, while the qualitative results offered a deeper understanding of learners' perceptions and usage patterns. Three significant themes identified in the interview data include: 1) the emergence of perceived usefulness of chatbots for IDLE through practical experimentation; 2) the increase in intention to use as learners navigate the affordances and constraints of chatbots; and 3) the actual utilization of chatbots for IDLE, where these tools function as tutors or conversation partners.

The initial finding indicated that the primary motivator for participants to accept and utilize DeepSeek technologies in their IDLE was the perceived usefulness. Half of the interviewees indicated that ease of use

might influence their perception of usefulness; however, all participants concurred that the potential usefulness primarily arises from the exploration of the technological affordances provided by DeepSeek technologies. The authors highlighted that DeepSeek chatbots, in contrast to earlier AI tools, are distinguished by their remarkable capabilities. Lu, a third year undergraduate user of DeepSeek, emphasized the notable features of the tool:

DeepSeek can serve as a valuable resource for my English language acquisition outside of the classroom, as it allows me to enhance my reading and writing skills through interaction.

Additionally, it can suggest effective English learning resources and methodologies akin to a teacher. Likewise, Xiao, a second-year student and ardent admirer of AI technology, remarked that:

The potential of emerging AI technologies is their capacity to engage in human-like conversations, offer adequate feedback, and even assist me in establishing my English learning objectives. It functions more as a personal tutor.

Lu and Xiao's discussion highlighted the significant advantages of DeepSeek chatbots, including facilitating intelligent conversations in the target language, providing resource recommendations, and offering personalized tutoring, thereby affirming the efficacy of DeepSeek tools as transformative AI technologies in English language acquisition. Fourteen interviewees said that the use of DeepSeek tools was evaluated not just based on technological functionality but also on the feature of open access. Sun, a third-year undergraduate user, states that:

The primary reason students find DeepSeek exceptionally beneficial is its great capability and cost-free access. We may leverage many English learning resources and chances for online English usage, provided we obtain access.

Sun's observation indicated that the availability of GPT chatbots at no cost may partially explain users' engagement.

Another common thread from the interviews was users' negotiation of the affordances and constraints associated with DeepSeek chatbots, which influenced their intention to adopt these technologies. In the initial interaction with DeepSeek technologies, 13 participants identified several limitations, including a monomodal interface, biased responses, inability to learn from experience, lack of common sense, and restricted contextual understanding. Wang, an English major student from third year, often employed DeepSeek Chat for her daily translation lesson's preparation and reflected on these limitations.

A potential issue is that AI technology occasionally generates responses that are not accurate. Therefore, it is not always possible to rely on the information it provides. Furthermore, it appears to be incapable of effectively relating to the context, and it will not function effectively when the instructions become overly complex...A specific level of proficiency is necessary to investigate its potential as an effective learning instrument.

Wang's example illustrated the advancement of metacognitive awareness in the utilization of AI tools. This awareness may encourage participants to implement strategies that enhance their confidence and preparedness in using AI for informal English learning. 15 of the twenty participants emphasized the importance of appropriate conversational prompts as a strategy for enhancing AI chatbots' ability to produce contextually accurate responses. Zhang and Tan, both studying computer science and possessing knowledge of natural language processing, shared the following:

DeepSeek continues to possess numerous constraints, particularly in its capacity to comprehend user input. In order to ensure that DeepSeek is both effective and pleasurable, it is necessary for individuals to provide appropriate prompts. It is akin to the fact that the intended answer cannot be obtained if the correct keywords are not entered into the Baidu/Firefox web search (Zhang).

The use of appropriate prompts in DeepSeek is crucial because it is a governing principle for the large language model to generate the intended outputs. Therefore, if I require a more contextualized and precise response from DeepSeek, I will first consider the prompts that DeepSeek can comprehend (Tan).

Moreover, the interviewees indicated a variety of DeepSeek-mediated IDLE activities, such as utilizing AI to generate vocabulary games for English language acquisition, obtaining real-time grammar feedback from AI to improve grammatical skills, and participating in topic-specific discussions with DeepSeek to enhance pragmatic competence and ensure culturally appropriate language use. The primary functions of chatbots as tutors and conversation partners represented the most common application of DeepSeek chatbots for IDLE purposes. The interview findings corroborated the quantitative results by illustrating the diversity of AI-IDLE activities and emphasizing two primary functions of the chatbots in IDLE practices. Yu, an undergraduate English major, often utilizes DeepSeek as a supplementary resource to aid his out-of-class English language learning and improve his understanding of original English novels. Figure 1 illustrates Yu's use of DeepSeek to analyze and interpret quotes from *Crime and Punishment*. Yu discovered that utilizing DeepSeek to explain the grammar and meaning of complex sentences in Chinese enhanced his English reading skills more effectively and with greater ease. The application of AI in informal language learning is exemplified by Lu, Zhang, and Tan, who utilized DeepSeek to enhance their speaking skills for the IELTS examination.

Use Chinese to explain the meaning and grammatical structure of the following quote from *Crime and Punishment*: He staggered down the street like a drunken man. Every sudden shout, every casual glance sent a shudder through him. He felt cut off from all humanity by an invisible curtain; though no one suspected his crime, the secret seemed to scream from his very pores.



中文解析《罪与罚》英文选段

1. 句子结构与语法分析

原文:

"He staggered down the street like a drunken man. Every sudden shout, every casual glance sent a shudder through him. He felt cut off from all humanity by an invisible curtain; though no one suspected his crime, the secret seemed to scream from his very pores."

逐句拆解:

1. "He staggered down the street like a drunken man."

- **主语 (Subject):** He (拉斯柯尔尼科夫)
- **谓语 (Verb):** staggered (蹒跚而行, 过去式)
- **状语 (Adverbial):** down the street (沿街道); like a drunken man (像醉汉一样, 明喻)
- **语法重点:** "like + 名词" 构成明喻 (simile), 强调他精神恍惚的状态。

2. "Every sudden shout, every casual glance sent a shudder through him."

- **主语 (Subject):** Every sudden shout, every casual glance (每个突然的叫喊、随意的目光)

Figure 1. Illustration of using DeepSeek for reading comprehension.

DISCUSSION

The research illustrates the various applications of emerging AI technologies in IDLE activities. Consistent with prior IDLE research (Lee & Lee, 2021; Zhang & Liu, 2022), the descriptive statistics indicate that participants in this study regularly employ new technologies for various receptive IDLE activities, including the collection and integration of authentic English learning resources (Q23, $M = 4.14$, $SD = 0.96$), as well as productive IDLE activities aimed at enhancing English communication skills (Q10, $M = 4.03$, $SD = 1.06$). The interview results highlight participants' innovative and effective use of AI in informal English learning, including reading English novels and practicing IELTS English with DeepSeek as a conversational partner. The variety of activities demonstrates that emerging AI technologies can function as effective and reliable instruments for enhancing creative and productive language learning outside the classroom (Cai, 2023; Soyoof et al., 2023; Yan, 2023).

Secondly, the interview results indicate that learners, acknowledging the limitations of chatbots, are driven to formulate suitable prompts and critically assess the generated outputs, highlighting practices that warrant further investigation. Engagement with AI-powered chatbot tools necessitates particular methods for assembling linguistic resources, specifically through the formulation of suitable prompts, as well as interpreting the genres and discourse structures produced by these tools. Therefore, there is a critical need to further comprehend the components of AI literacies. AI literacies are defined by researchers as a collection of skills that enable individuals to assess, communicate, and collaborate effectively with AI, as well as to employ AI as a tool in various environments, including online, home, and workplace contexts (Su et al., 2023; Weng & Chiu, 2023). We propose AI literacies as practices that involve negotiating the affordances and constraints of AI platforms to achieve specific goals, while maintaining a critical awareness of the designs, algorithmic processes, and datasets that underpin these platforms, recognizing that literacies are context dependent. This definition of a specific form of digital literacy highlights the necessity for critical awareness regarding lexical, syntactical, and pragmatic choices in interactions on AI chatbot platforms, which influence the production of information. This negotiation requires ongoing experimentation and refinement of prompts, alongside a cognitive understanding of the tools' affordances and constraints, as well as an attitudinal readiness to engage with them continuously. This context indicates that AI literacies warrant increased focus in language education research to illuminate the specific competencies, attitudes, and dispositions required for the effective and autonomous use of AI tools (Darvin, 2019; Darvin, 2023; Darvin & Hafner, 2022).

CONCLUSION

This study employed an explanatory sequential mixed-method approach, utilizing the Technology Acceptance Model (TAM) to investigate the recognition and acceptance of DeepSeek among Chinese EFL learners in informal digital English learning contexts. The interview data provided a detailed understanding of how learners utilize the advantages and limitations of advanced AI technologies to participate in diverse and innovative IDLE practices.

This study has limitations that warrant acknowledgement, despite the results obtained. Initially, purposive sampling was utilized to recruit participants with significant experience using GPT technology from social media platforms for feasibility purposes. Future research, however, may consider employing random or stratified probability sampling to enhance generalizability. This study provides a preliminary overview of GPT technologies in informal English language learning; however, longitudinal studies are necessary to investigate L2 learners' use of AI both in and out of the classroom. The online questionnaire utilized in this study excluded external variables such as computer self-efficacy to maintain the respondent-friendliness of the design. Future research should examine the influence of these variables on users' acceptance of emerging AI technologies.

This study presents multiple implications for educators and relevant stakeholders. It highlights the educational potential of Deepseek and calls on instructional designers and policymakers to recognize their value in promoting creative engagement with IDLE. Reimagining language pedagogy to incorporate AI affordances allows language teachers to facilitate the development of autonomous learning strategies in students. Second, since learners in this study demonstrate a willingness to utilize DeepSeek for various IDLE activities, language educators should consider designing connecting activities that align with pedagogical goals and support students' AI-assisted personalized learning outside the classroom. Expanding the agenda of utilizing AI in language learning requires the cultivation of critical awareness among teachers and students regarding the influence of AI technologies on user behaviors, actions, and thoughts. This is a long-term endeavor that warrants a nuanced and context-specific examination.

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