

# Exploring Digital Literacy in Informal Digital Learning of English among Chinese Undergraduate Students

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## Abstract

This mixed-methods study investigates the use of digital literacy in informal digital learning of English (IDLE) among 143 Chinese undergraduate students through exploration of their use and perceptions of digital literacy in IDLE. Results from a digital literacy and informal digital learning of English questionnaire and semi-structured interviews show that Chinese undergraduate students have proficient levels of digital literacy skills and participate in IDLE with moderate frequency, while they underutilize digital literacy skills in their IDLE practices. Further, they hold positive and supportive attitudes toward digital literacy in IDLE, revealing that digital literacy skills are useful and helpful in their IDLE practices. Implications lead to strengthen the development of digital literacy skills and strategies for students' participation in IDLE, support positive perceptions of digital literacy for IDLE, and highlight the potential of digital literacy to support IDLE.

**Keywords:** digital literacy, informal digital learning of English, perceptions, Chinese undergraduate students

## 1. Introduction

### 1.1 Background

In the 21st century, the rapid advancement and proliferation of digital technology have affected people's daily lives, learning and work across various fields. In response to this trend, scholars and practitioners have developed the field of digital literacy, expanding beyond the use of technology to include a set of abilities related to searching, filtering information and critical thinking in digital environments (Hafner, 2019). Digital literacy has become increasingly important for the learning and everyday life of second language learners (Grabe & Yamashita, 2022), this highlights the importance of supporting learners to develop and apply digital literacy effectively in their English language learning (Son, Park, & Park, 2017).

As digital technology and online resources become increasingly accessible to students, informal digital learning of English (IDLE) has emerged as a complementary approach to traditional in-class language education. Defined as autonomous and informal English language learning through digital devices and resources beyond the classroom (Lee & Dressman, 2018), IDLE places greater emphasis on students' autonomy and access to digital equipment and resources. However, it should be noted that students who can use such digital tools are not necessarily capable of effective English learning outside the classroom (Lai, Zhu, & Gong, 2014).

In China, where digital technology is widely accessible, students generally have good access to the Internet and digital resources, with many holding positive attitudes toward digital technology and digital learning (Rao, Lee, Fdilal, Bouziane, & Dressman, 2024; He & Wray, 2016). However, similar to the current state of education in South Korea mentioned by Lee's (2020) research, the traditional classroom-based education and exam-oriented approach still dominate China's education system, factors such as heavy academic workload may hinder students' digital literacy development and participation in IDLE. Despite the increasing attention of digital literacy and IDLE in English language education, their application within Chinese higher education context remains underexplored. The use of digital literacy in IDLE among Chinese undergraduate students has not yet been thoroughly investigated, their perceptions toward digital literacy in IDLE also need further exploration. Therefore, the study of the use of digital literacy in IDLE among Chinese undergraduate students continues to be of great value.

### *1.2 Theoretical Framework*

Digital literacy has evolved from basic use of digital devices to encompassing a broader range of skills in digital contexts. Scholars have proposed various theoretical frameworks to guide research and practice. This study adopts Son's (2015) five-element model as it provides a clear and practical framework: Information search and evaluation, creation, communication, collaboration and online safety, which aligns with the digital practices and challenges faced by Chinese EFL learners. Compared to other broader frameworks, it is more pedagogically actionable in language learning contexts. In education, digital literacy is increasingly recognized as critical. Scholars such as Tour (2020) and Jerasa and Boffone (2021) emphasize the pedagogical value of integrating digital tools and social platforms into English language learning. In China, Rao et al. (2024) note that students have reliable Internet access but lack guidance to develop their digital literacy skills. Wang (2023) also finds that EFL learners' digital literacy is linked to the academic productivity and technology-related stress.

IDLE refers to independent and informal English language learning through different digital tools and resources (Lee & Dressman, 2018) and includes activities like form-focused and meaning-focused IDLE (Lee, 2019), as well as receptive and productive IDLE activities (Lee & Drajeti, 2019). Studies have confirmed IDLE's positive effects on English vocabulary acquisition, speaking proficiency, and willingness to communicate (Lee, 2017; Lee & Dressman, 2018; Lee & Drajeti, 2019). In the Chinese context, Lai et al. (2014) find that English learning conducted outside the classroom can supplement formal classroom instruction but requires support from teachers and parents. Along with the work of Lee (2019) and Lee and Drajeti (2019), this study draws on Zhang and Liu's (2022) description of IDLE as autonomous, interest-driven English learning in non-classroom and digital contexts. This serves as a guiding framework for its emphasis on the integration of digital tools into language learning. It is supported by empirical studies in Asian contexts and is well-suited to capturing the informal and self-directed learning practices commonly observed among Chinese EFL learners.

Gonen and Kizilay (2023) find that Turkish university students need systematic guidance on digital literacy to help them to appropriately navigate digital learning contexts and access quality resources. Rezaei, Soyoof, and Reynolds (2024) assert that students who demonstrate higher digital literacy in the Iranian EFL setting tend to benefit more from IDLE, thereby improving their language learning. He and Zhu (2017) report that Chinese students' digital competence can directly affect their engagement in digital informal learning (DIL). Existing research also demonstrates the value of integrating measures of students' attitudes toward digital media into research (He, Huang, Yu, & Li, 2020), providing insights and support for the exploration of students' perceptions.

### *1.3 Research Objectives*

This study investigates the use of digital literacy in IDLE among Chinese undergraduate students, as well as their perceptions, with the aim of guiding students seeking to develop their digital literacy and enhance their self-directed English learning practices. And this study also offers valuable insights and empirical support for educators developing English language education in the era of digitalization. Accordingly, the research objectives of this study are:

- (1) To investigate the use of digital literacy in informal digital learning of English (IDLE) among Chinese undergraduate students.
- (2) To explore the perceptions of Chinese undergraduate students toward digital literacy in informal digital learning of English (IDLE).

## **2. Method**

### *2.1 Research Design*

A mixed-methods research approach is adopted in this study to explore the use of digital literacy in IDLE among Chinese undergraduate students, as well as their perceptions toward digital literacy in IDLE. This study collected quantitative data with a digital literacy and informal digital learning of English questionnaire, and conducted semi-structured interviews to gather qualitative data.

### *2.2 Participants*

Study participants were undergraduate students from universities in different regions of China. They were mixed genders and were distributed from grade one to four and represented a variety of majors. In the quantitative phase of the main study, 143 Chinese undergraduate students completed the questionnaire. Employing a convenience sampling method to select participants based on their availability and accessibility (Dörnyei & Taguchi, 2009), this study invited three students who indicated on the questionnaire their wish to participate in

the semi-structured interviews for the qualitative phase.

### 2.3 Instruments

The instruments applied in the research included a digital literacy and informal digital learning of English questionnaire and semi-structured interviews. Both instruments were conducted in Chinese.

#### 2.3.1 Digital Literacy and Informal Digital Learning of English Questionnaire

The comprehensive questionnaire was constructed based on the theoretical frameworks and questionnaire structures of related studies and consisted of four sections: (1) Demographic Information, (2) Digital Literacy, (3) Informal Digital Learning of English (IDLE), (4) Perceptions toward Digital Literacy in Informal Digital Learning of English (IDLE). First, using Son's (2015) theory and questionnaire on digital literacy as a basic framework, combining the studies of Pegrum, Hockly, and Dudeney (2022) and Fang and He (2022) to constructed the second section of this questionnaire, which utilized a five-point Likert scale with 1 indicating "Very Poor" to 5 indicating "Very Good". Second, the third section was modified and adapted from Lee (2019), Lee and Drajadi (2019) and Zhang and Liu's (2022) studies of IDLE and their questionnaires, and questions were on a five-point Likert scale with 1 meaning "Never" to 5 meaning "Very Often". Third, related studies by Son et al. (2017), Lee, Chen and Drajadi (2024), Chigbundu and Oluwabiya (2023) were used to construct the fourth section, where questions were asked using a five-point Likert scale of 1 for "Strongly Disagree" to 5 for "Strongly Agree".

Before implementing the main study, this questionnaire was tested through Item-Objective Congruence (IOC) by three experts and then piloted with 30 students. Prior to data analysis, the validity and reliability of the questionnaire were confirmed through exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and Cronbach's alpha coefficient values with 143 participants. Based on the results of EFA and CFA, some items were excluded or shifted to other dimensions, and then the adjusted version was evaluated via Cronbach's alpha coefficient values.

In the EFA phase, Kaiser-Meyer-Olkin measurements greater than 0.60 and Bartlett's test for significance were first used to test whether this section was adequate to proceed with the factor analysis (Howard, 2016). The results indicated that the datasets in Section 2 (KOM = 0.89,  $X^2 = 2200.86$ ,  $P < 0.01$ ), Section 3 (KOM = 0.90,  $X^2 = 1527.41$ ,  $P < 0.01$ ), and Section 4 (KOM = 0.89,  $X^2 = 741.89$ ,  $P < 0.01$ ) of this questionnaire were suitable for further factor analysis. As shown in Table 1, five factors were identified within Section 2, four factors within Section 3 and two factors in Section 4, with factor loading ranging from 0.61 to 0.91 and cumulative variance ranging from 68.41% to 79.54%, meaning the factors in this questionnaire hold practical significance (Hair, Babin, Anderson, & Black, 2019).

Table 1. Exploratory Factor Analysis of the Questionnaire (N = 143)

Section	Factor	N of Items	Factor Loading Range	Cumulative Variance (%)
Section 2 Digital Literacy	Information Search and Evaluation	4	0.64 - 0.81	14.32
	Creation	4	0.61 - 0.83	27.46
	Communication	4	0.65 - 0.79	40.59
	Collaboration	4	0.67 - 0.80	54.74
	Online Safety	5	0.78 - 0.87	74.72
Section 3 Informal Digital Learning of English (IDLE)	Form-focused IDLE	3	0.64 - 0.91	16.77
	Meaning-focused IDLE	4	0.63 - 0.78	34.42
	Receptive IDLE Activities	2	0.80 - 0.80	47.74
Section 4 Perceptions	Productive IDLE Activities	5	0.72 - 0.90	79.54
	Views and Attitudes	4	0.63 - 0.84	30.22
	Perceived Usefulness	5	0.71 - 0.84	68.41

For the CFA phase presented in Table 2, the discriminant validity was confirmed by the square root of the average variance extracted (AVE) for each factor exceeding the maximum of the absolute values of the correlation coefficients between the factors (Hair et al., 2019). According to Fornell and Larcker (1981) and Hair et al. (2019), assessment of convergent validity includes the following criteria: the composite reliability (CR) is above 0.7 and the AVE exceeds 0.5. The results of factor loadings ranging from 0.61 to 0.92, AVE ranging from 0.52 to 0.78, and CR ranging from 0.76 to 0.95 indicated that each section of this questionnaire has good

convergent validity.

Moreover, the Cronbach's alpha coefficient values for the three sections ranged from 0.91 to 0.94, and the overall Cronbach's alpha coefficient reached 0.94, indicating that each section and the overall questionnaire were at a good level of reliability (George & Mallery, 2016). To summarize, the results of the exploratory factor analysis, confirmatory factor analysis and Cronbach's alpha coefficient values indicated the validity and reliability of this questionnaire.

Table 2. Validity and Reliability of the Questionnaire (N = 143)

Section	Factor	N of Items	Convergent Validity			Cronbach's Alpha
			Factor Loading Range	AVE	CR	
Section 2 Digital Literacy	Information Search and Evaluation	4	0.76 - 0.89	0.68	0.89	0.89
	Creation	4	0.71 - 0.87	0.62	0.87	0.86
	Communication	4	0.61 - 0.90	0.61	0.86	0.85
	Collaboration	4	0.76 - 0.83	0.62	0.87	0.87
	Online Safety	5	0.81 - 0.87	0.71	0.93	0.93
Section 2		21	N/A	N/A	N/A	0.94
Section 3	Form-focused IDLE	3	0.69 - 0.85	0.62	0.83	0.82
Informal Digital Learning of English (IDLE)	Meaning-focused IDLE	4	0.73 - 0.90	0.66	0.88	0.88
	Receptive IDLE Activities	2	0.74 - 0.83	0.61	0.76	0.76
	Productive IDLE Activities	5	0.78 - 0.92	0.78	0.95	0.94
Section 3		14	N/A	N/A	N/A	0.93
Section 4	Views and Attitudes	4	0.71 - 0.75	0.52	0.81	0.81
Perceptions	Perceived Usefulness	5	0.66 - 0.87	0.64	0.90	0.90
Section 4		9	N/A	N/A	N/A	0.91
Overall Questionnaire		44	N/A	N/A	N/A	0.94

### 2.3.2 Semi-Structured Interview

The qualitative data collected from the semi-structured interviews provided a more in-depth interpretation of participants' responses from the questionnaire. 14 open-ended questions were divided into three sections to collect qualitative data on the following themes: Chinese undergraduate students' (1) views of their digital literacy and IDLE, (2) experience of using digital literacy in IDLE, and (3) perceptions toward digital literacy in IDLE. Three experts used IOC to evaluate the interview questions, which were also piloted with two students before the main study.

### 2.4 Data Collection and Analysis

The questionnaire was distributed via e-posters with a QR code. The questionnaire could be completed through the online platform Wenjuanxing, through which 143 valid responses were received. The semi-structured interviews with three participants were conducted through an online conference application, interviewees' responses were noted and recorded with their consent, and then each interview was transcribed for analysis.

The quantitative data analysis was conducted via IBM SPSS, mean score ( $\bar{x}$ ) and standard deviation (S.D.) were calculated to summarize the participants' responses, offering a clear picture of their use of digital literacy in IDLE, as well as students' perceptions. For the qualitative data analysis, a thematic analysis was applied to support and further interpret the questionnaire findings.

## 3. Results

### 3.1 The Use of Digital Literacy in Informal Digital Learning of English (IDLE)

Overall, Chinese undergraduate students had a relatively high mean score of digital literacy—a "Good" level ( $\bar{x}$  = 3.89, S.D. = 0.51), and students participated moderately in IDLE "Sometimes" ( $\bar{x}$  = 3.12, S.D. = 0.68). Of the five dimensions of digital literacy, the highest was Online Safety ( $\bar{x}$  = 4.11, S.D. = 0.61), the lowest was Communication ( $\bar{x}$  = 3.75, S.D. = 0.70), and the skills of Information and Evaluation ( $\bar{x}$  = 3.83, S.D. = 0.62), Creation ( $\bar{x}$  = 3.87, S.D. = 0.60), and Collaboration ( $\bar{x}$  = 3.84, S.D. = 0.61) were at a "Good" level as well. For IDLE, among the four types of IDLE activities, the most frequent was form-focused IDLE ( $\bar{x}$  = 3.52, S.D. = 0.74), and the least frequent was productive IDLE activities ( $\bar{x}$  = 2.79, S.D. = 0.92), with students sometimes

participating in meaning-focused IDLE ( $\bar{x} = 3.08$ , S.D. = 0.80), and participating relatively often in receptive IDLE activities ( $\bar{x} = 3.41$ , S.D. = 0.75).

The use of digital literacy in IDLE was investigated through 14 specific items. The results in Table 3 revealed the frequency of the activities and their associated digital literacy dimensions. Chinese undergraduate students applied digital tools or platforms to participate in activities such as checking the pronunciation of English words ( $\bar{x} = 3.56$ , S.D. = 0.86), practicing vocabulary ( $\bar{x} = 3.52$ , S.D. = 0.82), looking up the meaning of English words ( $\bar{x} = 3.49$ , S.D. = 0.90), and watching English content ( $\bar{x} = 3.48$ , S.D. = 0.82) fairly often. These activities were primarily associated with Information Search and Evaluation and Communication, indicating that digital literacy skills of searching, evaluating and communicating were widely used in IDLE. Activities involving Creation, Collaboration and Online Safety, such as writing English content online ( $\bar{x} = 2.80$ , S.D. = 1.00), participating in online discussions ( $\bar{x} = 2.78$ , S.D. = 1.02), or chatting in English through social media ( $\bar{x} = 2.88$ , S.D. = 1.02)—received lower mean scores, indicating only occasional participation and use.

Table 3. The Use of Digital Literacy in IDLE

Items	Corresponding Digital Literacy Dimensions	Mean	S.D.	Meaning
Form-focused IDLE				
1. Use online English dictionaries to look up meaning or usage of English words.	Information and Evaluation	3.49	0.90	Fairly Often
2. Use apps or platforms (e.g., Youdao Dictionary) to check pronunciations or example sentences of English words.	Information and Evaluation	3.56	0.86	Fairly Often
3. Practice or review English vocabulary using vocabulary apps (e.g., Baicizhan).	Information and Evaluation	3.52	0.82	Fairly Often
Meaning-focused IDLE				
4. Watch English grammar explanations through online platforms (e.g., Bilibili), to learn and recognize knowledge of grammar rules.	Information and Evaluation	3.13	0.87	Sometimes
5. Use online tools (e.g. Grammarly) to check and correct English grammar errors and improve grammatical accuracy.	Information and Evaluation	3.01	1.05	Sometimes
6. Read English posts on social media for understanding ideas.	Information and Evaluation / Communication	2.99	0.89	Sometimes
7. Watch English videos on digital platforms (e.g., Douyin) to learn about and discuss topics of interest.	Information and Evaluation / Communication / Collaboration	3.21	0.91	Sometimes
Receptive IDLE Activities				
8. Watch English movies, TV shows, or TV series online to improve English listening comprehension skills.	Information and Evaluation / Communication	3.48	0.82	Fairly Often
9. Listen to English music, podcasts, or audiobooks online to improve English listening adaptability.	Information and Evaluation / Communication	3.34	0.84	Sometimes
Productive IDLE Activities				
10. Chat with others in English through social media, to enhance daily English expression skills.	Communication / Online Safety	2.88	1.02	Sometimes
11. Participate in online discussions or forums in English, to enhance English writing and expression skills.	Communication / Collaboration	2.78	1.02	Sometimes
12. Have video- or audio-calls with others in English, to improve English speaking skills.	Communication	2.66	1.05	Sometimes
13. Share English contents (e.g., videos, blogs) online, to enhance English content output ability.	Creation	2.81	0.97	Sometimes
14. Write emails, posts, or articles in English online, to enhance written English writing skills.	Creation	2.80	1.00	Sometimes

The qualitative data obtained from the interviews also yielded consistent information. For Chinese undergraduate students' digital literacy, all interviewees demonstrated that they were able to use relevant digital literacy skills, as Student 1 noted, "I feel that I am proficient in all five dimensions of skills, whether for learning or for fun." For the use of digital literacy in IDLE, there were gaps among different interviewees in the participation in IDLE and their use of digital literacy skills, and students showed strong information search and communication skills within their IDLE practices. As Student 1 noted, "I very often use the Youdao app to look up words, and I use Baicizhan every day to practice and review words. I also frequently search and listen to VOA and BBC to practice my English listening skills," while Student 2 stated, "I sometimes find and watch some American TV shows or message my classmates in English, but I rarely read English content or talk to others in English." However, despite the high scores for Online Safety, few students mentioned applying relevant skills specifically in their IDLE practices, as Student 3 said, "I know how to protect my accounts, but I rarely thought about online safety when learning English online," indicating their limited awareness of online safety in learning contexts.

### 3.2 Perceptions toward Digital Literacy in Informal Digital Learning of English (IDLE)

In sum, Chinese undergraduate students generally had a high level of agreement of perceptions toward digital literacy in their IDLE ( $\bar{x} = 3.80$ , S.D. = 0.47). In terms of the two dimensions included, students were positive and supportive of digital literacy in IDLE ( $\bar{x} = 3.75$ , S.D. = 0.53), and perceived digital literacy skills as useful and helpful in their IDLE practices ( $\bar{x} = 3.84$ , S.D. = 0.49).

As shown in Table 4, regarding the views and attitudes, Chinese undergraduate students generally held positive attitudes toward digital literacy in IDLE ( $\bar{x} = 3.87$ , S.D. = 0.61), they knew the usage of digital technology that used in IDLE activities ( $\bar{x} = 3.73$ , S.D. = 0.66). In addition, they expressed a preference for using digital technology or platforms for IDLE ( $\bar{x} = 3.71$ , S.D. = 0.69), while they were relatively less confident in conducting IDLE activities across different digital platforms ( $\bar{x} = 3.68$ , S.D. = 0.67). For the perceived usefulness, students generally agreed that digital tools and resources can make their IDLE more efficient ( $\bar{x} = 3.85$ , S.D. = 0.58) and enhance the learning outcomes ( $\bar{x} = 3.83$ , S.D. = 0.57). Moreover, they believed that digital literacy skills could help them access high-quality resources ( $\bar{x} = 3.83$ , S.D. = 0.60), enhance their learning abilities ( $\bar{x} = 3.85$ , S.D. = 0.60), and conduct IDLE more efficiently ( $\bar{x} = 3.87$ , S.D. = 0.57).

Table 4. Perceptions toward Digital Literacy in IDLE

Items	Mean	S.D.	Meaning
Views and Attitudes			
1. Be aware of the digital technology (e.g., dictionary apps or online course platforms) used for IDLE.	3.73	0.66	Agree
2. Hold a positive attitude toward the use of digital tools for IDLE.	3.87	0.61	Agree
3. Be confident navigating different digital platforms for IDLE.	3.68	0.67	Agree
4. Prefer IDLE through digital technology or platforms.	3.71	0.69	Agree
Perceived Usefulness			
5. Digital tools can make IDLE more efficient.	3.85	0.58	Agree
6. Digital tools and resources can enhance the outcomes of IDLE.	3.83	0.57	Agree
7. Digital skills help me access high-quality IDLE resources.	3.83	0.60	Agree
8. Digital literacy can enhance my abilities in IDLE (e.g., search and evaluate information).	3.85	0.60	Agree
9. Digital literacy training can help me conduct IDLE more efficiently.	3.87	0.57	Agree

Correspondingly, similar positive perceptions from the interviewees were observed, with Chinese undergraduate students mentioning that they enjoy the benefits of digital literacy in learning English in informal digital learning contexts. For instance, Student 1 expressed, "I enjoy using digital tools to learn English in a digital environment outside the class because they help me find the latest updated learning resources," and Student 2 noted, "I find it convenient to use digital tools or platforms to learn English in digital environments, especially because I can even complete many learning activities with just my mobile phone." Furthermore, they emphasized the positive impact that improved digital literacy skills may have on IDLE, as Student 3 stated, "I believe that increasing digital literacy skills can not only play a positive role in IDLE, but can be a help in all aspects of our lives and learning, thus enhancing our comprehensive competence."

## 4. Discussion

### 4.1 *The Use of Digital Literacy in Informal Digital Learning of English (IDLE)*

This research reveals that Chinese undergraduate students typically demonstrate a good level of digital literacy, which aligns with Rao et al.'s (2024) conclusion that Chinese students have good Internet access and a variety of digital media to support their engagement with extensive online materials. Chinese undergraduates' participation of IDLE remains moderate and variable. Similar to the state of education in South Korea mentioned by Lee (2020), the traditional in-class and exam-oriented education still dominate China's education system, where heavy academic workloads may restrict students' participation in out-of-class digital English learning activities. Additionally, digital literacy skills are not being fully utilized in students' IDLE practices, which coincides with Grabe and Yamashita's (2022) report that although many students are skilled in using digital devices for non-academic purposes, they often face challenges when applying these tools in academic contexts. And insufficient recognition and guidance from parents and teachers may also reduce students' practice (Lai et al., 2014).

### 4.2 *Perceptions toward Digital Literacy in Informal Digital Learning of English (IDLE)*

The findings also suggest that Chinese undergraduate students generally hold positive perceptions toward digital literacy in IDLE, aligning with the findings of He and Wray (2016) showing that Chinese students generally hold positive attitudes toward digital technology and digital learning. Students are found to enjoy the application of digital tools for self-directed English learning in informal digital settings (Li, Cao, & Wang, 2020), and recognize the usefulness of digital literacy for their IDLE practices (Pertiwi & Rojab Siti, 2022). Compared with the generally positive perceptions toward digital literacy in IDLE among Chinese undergraduate students, students' lower use of digital literacy in IDLE can be attributed to the current state of English language education (Lee, 2020), differences in interests and needs, insufficient understanding of digital literacy and IDLE, and a lack of guidance and support (Zhang & Liu, 2022).

### 4.3 *Implications*

The results of this research offer meaningful practical insights for English language learners and educators. First, learners should be aware of and strengthen their digital literacy to better serve their English language learning in digital environments. Educators should also attend to the importance of digital literacy, which can provide rich digital resources for English education, offer more diverse forms and contents for class activities, and create more possibilities for English language learning and teaching (Pegrum, Dudeney, & Hockly, 2018). For instance, to effectively incorporate digital literacy into English language instruction (Son et al., 2017), educators can develop digital literacy toolkits that include curated digital resources, language learning websites, mobile applications, and online activities. Meanwhile, a digital mentoring system is encouraged to be established to guide students in selecting, using, and reflecting on digital tools and platforms for language learning, thereby enhancing their digital literacy skills.

Second, students' positive perceptions toward digital literacy in IDLE highlight the potential of digital literacy to support IDLE. The development trends and benefits of IDLE cannot be ignored, as it supplements and extends in-class English language learning, working together to support students' English language learning (Dressman & Lee, 2021). In light of this, educators should provide students with appropriate guidance and assistance to encourage their active participation in IDLE activities. For example, teachers can incorporate IDLE journals as part of assignments to motivate students to record their informal English learning outside the classroom. In addition, peer-learning platforms or discussion forums can be created to enable students to share their IDLE experiences, resources and strategies, and to raise awareness of various IDLE practices.

### 4.4 *Limitations*

While this study provides valuable insights into the use of digital literacy in IDLE among Chinese undergraduate students, as well as their perceptions, some limitations should be acknowledged. First, the sample size of 143 participants and the use of convenience sampling, although sufficient for statistical analysis, may not be representative of all Chinese undergraduate students. Future research could expand the size and diversity of the sample to obtain more generalizable data. Second, the study primarily relies on self-reported data, which may result in subjective biases or inaccurate assessments of students' digital literacy and IDLE. Future studies could incorporate objective assessments of digital literacy skills and actual IDLE behaviors. Third, this study was conducted within the cultural and educational context of China, which may limit the generalizability of the findings to students from different cultural backgrounds. Future research could include comparative studies across regions or countries to better understand contextual influences.

## 5. Conclusion

This study explored the use of digital literacy in IDLE among Chinese undergraduate students, as well as their perceptions toward digital literacy in IDLE. The findings reveal that digital literacy skills are insufficiently used by Chinese undergraduate students in their IDLE practices, and they generally hold positive perceptions toward digital literacy in IDLE. This study enriches current understanding of digital literacy and IDLE, providing practical insights for English language learners and educators. Developing digital literacy skills and utilizing students' positive perceptions of digital tools and platforms effectively supports informal English language learning in digital environments.

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## Authors contributions

The sole author was responsible for the study design, data collection, analysis, and manuscript preparation. The author read and approved the final manuscript.

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No additional data are available.

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