

Research Article:

Mapping Informal Digital Learning of English (IDLE): A Bibliometric Analysis of Citation, Co-Occurrence, and Co-Citation (2000–2024)

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ABSTRACT

This bibliometric study maps the global evolution of Informal Digital Learning of English (IDLE) research from 2000 to 2024. Adhering to PRISMA guidelines, we analysed 330 Scopus-indexed documents to identify publication trends, key themes, and theoretical shifts through co-citation, co-occurrence, and network analyses. The findings reveal major thematic clusters (e.g., self-regulated learning, learner autonomy, IDLE, online learning, motivation), signaling a pivot from computer-assisted language learning (CALL) to more dynamic, ecological paradigms. Findings indicate a significant geographic concentration, with China contributing 52% of publications, which points to a potential regional bias. We conceptualise IDLE not as a linear extension of CALL, but as a complex, socio-technical ecosystem where autonomy, motivation, and context dynamically interact. We recommend that future research broaden regional perspectives, employ longitudinal and mixed-method approaches, and critically examine how generative AI tools reshape learning dynamics. For educators, this study cautions against a passive, “hands-off” approach to IDLE. The prominence of metacognitive and psychological factors underscores the need for teachers to act as facilitators who guide learners in developing learner autonomy, fostering motivation, and reflecting on their learning process across formal and informal settings.

Keywords: Bibliometric, IDLE, PRISMA, co-citation, co-occurrence, CALL

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INTRODUCTION

Language acquisition occurs through both formal and informal learning contexts (Lee, 2019). Research indicates that informal learning accounts for 70%–90% of knowledge acquisition, far outweighing formal education's contribution (Rogers, 2014). This is a dynamic, learner-directed process that occurs intentionally or spontaneously in unstructured settings without restrictions of space and time (Cross, 2011). The proliferation of digital technologies has profoundly transformed language acquisition, giving rise to informal digital learning of English (IDLE) (Lee, 2019). IDLE involves the autonomous use of digital devices and resources beyond the classroom, and overlaps with related concepts including “online informal learning of English”, “out-of-class autonomous language learning with technology”, and “language learning in the digital wild” (Lai, 2017; Sockett, 2023; Toffoli & Sockett, 2015).

Since its formal introduction in *Tesol Quarterly* (Lee & Dressman, 2018), IDLE has received increasing scholarly interest (Lee, 2021), establishing itself as a distinct yet subfield of computer-assisted language learning (CALL) research (Zhang & Liu, 2024). For comparison, we examined a comprehensive CALL review (Mohsen et al., 2024) from *ReCALL* journal, which analysed 4,631 Scopus-indexed records from 1980–2021. Key finding from this review revealed:

1. Technological innovation emerged as a central theme, evidenced by frequent keywords like computer-assisted language learning and MALL.
2. Social learning is crucial, evidenced by computer-mediated communication, interactive learning environments, and classroom instruction improvement.
3. Theories mainly grounded in socio-cultural and second language acquisition;
4. Pedagogical strategies featured in vocabulary acquisition, teaching/learning strategies, and classroom instruction improvement.

Despite the expansion of CALL, the extent to which IDLE aligns with or diverges from CALL in terms of themes, learning contexts, and theories remains underexplored (Soyoof et al., 2023).

Despite growing publications in high-impact journals and rapid expansion of IDLE research (Lee, 2021), a comprehensive, quantitative mapping of its evolution is still lacking. First, while existing reviews offer rich qualitative insights, they lack systematic visualisation of the growth, geographic distribution, and collaboration patterns in IDLE field. This makes it difficult to identify the most influential journals, authors, and countries, or to understand its social dynamics. Second, although key research themes (e.g., digital competence, ecological systems) have been identified, the

dynamic evolution of these themes and their co-occurrence relationships have not been sufficiently explored. Third, although IDLE is often framed as an outgrowth of CALL, its distinct theoretical identity is underexplored. A co-citation analysis can objectively trace the core theories and references that establish IDLE as a distinct paradigm for ecological and autonomous language learning.

To address these gaps, this study employs a bibliometric analysis of Scopus-indexed publications from 2000–2024. This analysis aims to provide valuable insights for language educators to guide their future research. Specifically, we sought to answer the following questions:

RQ 1: What journals, publications, researchers, and countries have been most influential in IDLE research?

RQ 2: What are the predominant research themes in IDLE studies?

RQ 3: In what ways does IDLE extend beyond CALL?

LITERATURE REVIEW

Technology advancements have revolutionised English language learning, extending opportunities beyond formal education settings. This shift has led to growing engagement in IDLE among L2 learners (Lee, 2019), a trend increasingly drawing research attention (Guo & Lee, 2023; Soyoo et al., 2023). However, there remains no unified understanding of themes, theories and constructs on IDLE. To explore IDLE perspectives, we analysed existing literature reviews. Currently, three systematic literature reviews and one scoping review have examined IDLE, as summarised in Table 1.

Table 1. Summary of reviews on IDLE

Reference	Types/Scope/TDE/ Database	Focus of review
Soyoo et al. (2023)	Scoping review/1980–2019/ <i>n</i> = 38/WoS	Langua-technocultural competence, digital literacies, non-professional translation, and interpreting in digital language learning.
Guo & Lee (2023)	SLR/2010–2021/ <i>n</i> = 103/ WoS	Micro-system, Meso-system, Exo-system, Macro-system, and Chrono-system levels affect IDLE.

Reference	Types/Scope/TDE/ Database	Focus of review
Wong et al. (2019)	SLR/2006–2016/ <i>n</i> = 35/ Scopus, Google Scholar, WoS, ERIC	SRL supports (i.e., prompts, feedback, and integrated support systems, benefit online learners differently).
Pérez-Álvarez et al. (2018)	SLR/2008–2018/ <i>n</i> = 38/ ACM Digital Library, IEEE Explorer, Science Direct, Scopus, SpringerLink	Interactive visualisations positively impact learners' motivation, the social comparison component enhances engagement and time management.

Note: TDE = total documents examined SLR: systematic literature review

These reviews address themes including digital competences (Soyoof et al., 2023), ecologic factors (Guo & Lee, 2023), and supports for self-regulated learning (SRL) (Pérez-Álvarez et al., 2018; Wong et al., 2019). For example, Soyoof et al. (2023) emphasise the essential digital competencies required for IDLE engagement, outlining competencies that learners must develop to utilise digital learning tools. They conceptualise IDLE as “out-of-class CALL context” and “subfield in CALL”, framing it within dimensions such as linguistic, affective-cultural, and digital literacies. Building on their study, Guo and Lee (2023) further explored ecologic and dynamic factors of IDLE, categorising them into individual, micro-system, meso-system, exo-system, and chrono-system levels. Their research highlights factors like personal interests, beliefs, motivations, teacher influence, peer interactions, online community engagement, family background, and media exposure. Wong et al. (2019) found that prompts are effective in enhancing SRL strategies, with continuous and context-specific prompts proving particularly beneficial.

While these reviews offer valuable insights, they are constrained by narrow corpora, qualitative methodologies, and publication timelines that predate recent advancements. For instance, Soyoof et al.'s (2023) analysed a small sample of 38 documents from the Web of Science while others focused on specific sub-domains like self-regulated learning (Wong et al., 2019) rather than the entire IDLE landscape. More critically, these reviews are inherently descriptive and qualitative, making it difficult to objectively identify the field's structure, including its most influential works, key thematic connections, and the co-citation lineages. Furthermore, as they were conducted before the recent surge in publications and the rise of generative AI, they cannot capture the field's current trajectory. For this reason, a bibliometric analysis spanning 2000 to 2024 offers a more comprehensive perspective on the evolution and trends of IDLE.

METHODOLOGY

Quantitative (bibliometric analysis) method was employed in this study. Bibliometric analysis was used to manage extensive literature and minimise bias in document selection. It has been widely applied in various fields, including technology-aided learning (Wang & Kabilan, 2024), L2 acquisition (Sun & Lan, 2023), and psychology (Kúld et al., 2020). In this study, bibliometric analysis helps to explore research dynamics and trends of IDLE.

Data Selection

Scopus was chosen based on two reasons:

1. Scopus is recognised as the world’s largest abstract and citation database for peer-reviewed literature in social science, covering broader topics compared to other databases (Ruiz-Pomeda et al., 2020).
2. VOS viewer was not advisable to merge two databases for coding bibliographic metadata (Arruda et al., 2022).

Searching Process

Based on the research questions, we formulated the search strings by identifying core keywords, along with their synonyms and variations. To refine the results, wildcard and Boolean operator were used in combination with these keywords (Ahmi, 2022; Soyooof et al., 2023). The selection of terms was methodically designed to capture the intersection of digital technology, learner informality, and English language acquisition. Keywords were categorised into specific domains to broaden the search scope and enhance the retrieval of relevant articles. For example, informal learning was expanded to “learning beyond the classroom”, “learning outside the classroom”, or “learning in the digital wild” (see Table 2). Specific language skills like “grammar” and “vocabulary” were prioritised because they represent the most frequently researched and explicitly tagged competencies in the literature, in contrast to broader, more complex constructs like “fluency” or “pragmatics”.

Table 2. Inclusion criteria and search strings

Language	English
Time frame	2000-10 November 2024
Publication	Peer-reviewed journal articles
Database	Scopus
Discipline	English language learning

(Continue on next page)

Table 2 (Continued)

Language	English
Search strings	digital OR technology OR computer OR mobile OR online OR internet OR multimedia OR virtual OR “augmented reality” OR web OR platform OR AI OR MALL OR CALL OR e-learning OR elearning OR “distance learning” OR “d-learning” OR “m-learning”) AND (informal OR self-direct* OR “beyond the classroom” OR extramural OR “self-regulat*” OR “outside the classroom” OR “out of classroom” OR out-of-classroom OR autonom*) AND (EFL OR English OR L2 OR ESL OR “English skill*” OR “language learning” OR “reading” OR “writing” OR “speaking” OR “grammar” OR “vocabulary”

Timeframe

The investigations into IDLE began to emerge around 2010 (Soyooft et al., 2023), and the term IDLE was formally introduced in 2018 (Lee & Dressman, 2018). However, this study covered publications prior to 2010 to include those not explicitly categorised as IDLE but still contributing insights to the review (Soyooft et al., 2023). Using the searching strings, the first relevant article was retrieved in 2000. Consequently, the study timeframe was set from 2000 to 2024.

Screening

To retrieve relevant publications, the study followed a structured approach, applying specific inclusion and exclusion criteria: database selection, research timeframe, retrieval guidelines, search strings, and language restrictions. The initial search yielded 543 records. During the screening phase, we applied the following exclusion criteria:

1. Document type: 173 non-peer-reviewed publications (e.g., book chapters, conference reviews, editorials) were excluded.
2. Language: 10 non-English publications were removed.
3. Relevance: 30 articles were excluded after a title and abstract screening determined they were unrelated to the research objectives.

Consequently, 330 articles qualified for final inclusion and bibliometric analysis (see Figure 1). The limited quantity can be attributed to a narrow scope and a deficiency of relevant knowledge on this emerging subject. According to Rogers et al. (2020), a bibliometric analysis should have a minimum sample size of 200 entries. Therefore, 330 articles are sufficient for this bibliometric analysis.

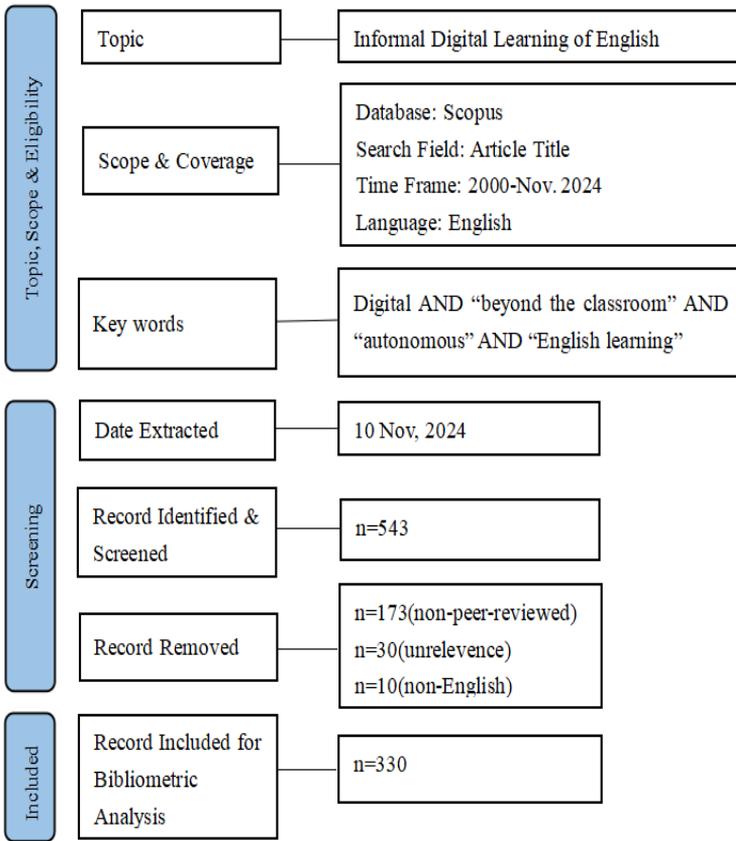


Figure 1. Flow diagram of data selection adapted from Zakaria et al. (2021)

Instrument

Bibliometrics applies mathematical and statistical methods to evaluate and predict trends in a specific discipline (Mohsen et al., 2024). In this study, VOS viewer (version 1.6.20) was used to visualise bibliometric networks by creating network visualisations, such as co-authorship, co-occurrence, and co-citation networks (Min & Yu, 2023). Additionally, CiteSpace (version 6.3 R1) served as a key scientometric tool providing visual representations of research status, hotspots, developments, and emerging frontiers (Zhou et al., 2024). Microsoft Excel 2019 was also used to count publications, analyse citation frequencies, and calculate the average citations per country or author.

Metrics for Publications

We initially ranked 330 articles based on citation counts from Scopus. Subsequently, we identified articles published in top-tier language and linguistics journals (all in Quartile 1) according to the 2020 SCImago Journal Rank (SJR), a metric that assesses scholarly journals based on citation weighting and eigenvector centrality (Huang et al., 2023). SJR is a reliable measure of journal quality commonly utilised in language reviews. Lastly, we selected the 10 most cited articles with at least 110 citations from reputable journals.

RESULTS

The following presents visualisations of publication distributions, the emerging themes in IDLE research, as well as theories employed in these studies.

Publication Distributions

Publications

Figure 2 illustrates the trends in IDLE research from 2000 to 2024. It shows a consistent rise in research interest in technology-assisted learning beyond the classroom. The number of studies steadily increased from 2000 to 2011 (averaging 1 article per year), then from 2012 to 2017 (averaging 9 articles per year), and from 2018 to 2021 (averaging 23 articles per year), experiencing a sharp increase in 2022 with 46 articles. Notably, the number of publications in 2023 was 5.2 times greater than in 2017, indicating a rising interest and acknowledgment of IDLE among researchers. As of November 2024, there are already 71 articles on IDLE.

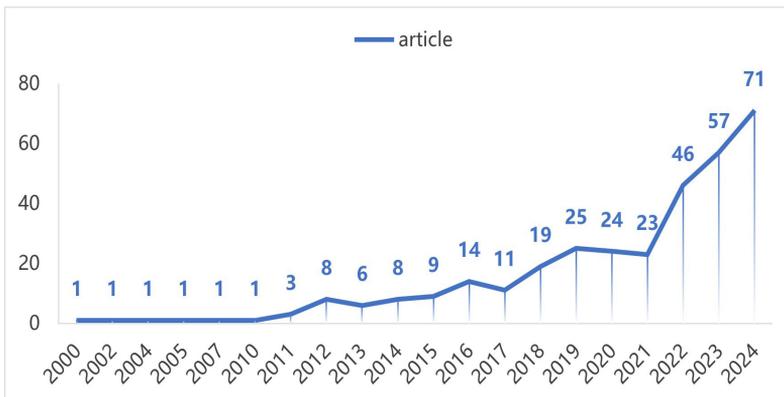


Figure 2. The number of publications of IDLE studies

To identify the most highly influential publications, we analysed the top 10 most cited sources from the 330 articles. Table 3 presents the top 10 publications that have been frequently cited from 2000 to 2024. These documents can be broadly categorised into three fields based on their research emphasis: (1) collaborative learning and autonomous learning (Kessler & Bikowski, 2010), (2) self-regulated or self-directed learning (Botero et al., 2019; Chen & Hsu, 2020; Chen & Huang, 2014; Rosell-Aguilar, 2018; Lai, 2015; Lai & Gu, 2011), and (3) digital gaming for language learning (Chik, 2014).

The most cited publication is "Developing collaborative autonomous learning abilities in computer-mediated language learning: Attention to meaning among students in wiki space", which has been referenced 238 times. Another highly cited work, referenced 235 times, is "Fostering learner autonomy in English for science: A collaborative digital video project in a technological learning environment". Notably, Lee (2019), with 113 citations, and Botero et al. (2019), with 112 citations, have emerged as significant recent contributions in IDLE.

Table 3. Top 10 most highly cited references

Researcher	Reference	NC	JCR
Kessler & Bikowski (2010)	Developing collaborative autonomous learning abilities in computer mediated language learning: Attention to meaning among students in wiki space	238	Q1
Hafner et al. (2011)	Fostering learner autonomy in english for science: A collaborative digital video project in a technological learning environment	235	Q1
Lai & Gu (2011)	Self-regulated out-of-class language learning with technology	227	Q1
Chen & Hsu (2020)	Self-regulated mobile game-based English learning in a virtual reality environment	142	Q1
Chik (2014)	Digital gaming and language learning: Autonomy and community	130	Q1
Chen & Huang (2014)	Web-based reading annotation system with an attention-based self-regulated learning mechanism for promoting reading performance	121	Q1
Lai (2015)	Modeling teachers' influence on learners' self-directed use of technology for language learning outside the classroom	113	Q1
Lee (2019)	Affective variables and informal digital learning of English: Keys to willingness to communicate in a second language	113	Q1
Rosell-Aguilar (2018)	Autonomous language learning through a mobile application: a user evaluation of the busuu app	112	Q1
García Botero et al. (2019)	Self-directed language learning in a mobile-assisted, out-of-class context: do students walk the talk?	112	Q1

Note: NC = number of citation; JCR = Journal Citation Reports

Influential journals

In this study, the researchers examined the journals that with the most citations on IDLE. Table 4 shows the top 10 journals, each having at least 140 citations. To specify, the journal with the most citations is *Computer Assisted Language Learning* ($n = 1,408$). It is worth mentioning that all of the journals are high-impact journals indexed in the Social Science Citation Index (SSCI) database under the categories “education,” “technology-assisted,” “language and linguistics”, or “psychology”. After analysing the number of citations per article, it is evident that the journals *Computer Assisted Language Learning* and *Language Learning & Technology* are prominent, indicating that English language researchers are increasingly focusing on IDLE through computer technologies.

Beyond this technological core, the journal landscape reveals a significant thematic expansion. For instance, *Frontiers in Psychology* reflects a growing acknowledgment of the psychological dimensions of informal learning, such as motivation and self-efficacy. Similarly, *Sustainability* underscores that learner autonomy, which is central to IDLE, is essential for lifelong learning. Collectively, these trends illustrate that IDLE is evolving into a cohesive paradigm, one that integrates technological, psychological, and pedagogical perspectives.

Table 4. Top 10 publication sources

Journals	NP	Total citations	JCR
Computer Assisted Language Learning	29	1408	Q1
Language Learning & Technology	8	722	Q1
System	16	474	Q2
Computers & Education	6	404	Q1
Recall	9	403	Q2
British Journal of Educational Technology	8	389	Q1
Australasian Journal of Educational Technology	5	256	Q1
Frontier in Psychology	18	218	Q2
Educational Technology Research and Development	5	151	Q1
Sustainability	6	143	Q2

Note: NP = number of publications; JCR: Journal Citation Reports

Influential researchers, countries, and institutions

Figure 3 lists the most productive authors in the IDLE field. Lee and Lai were the top contributors, with 17 and 12 articles respectively, followed by Liu and Liang, each with six articles. Notably, Lee is affiliated with The Education University of Hong Kong, Lai with The University of Hong Kong, and Liu with The Chinese University of Hong Kong. Liang is from the Chin Min Institute of Technology in Taiwan.

The geographic distribution of the 330 IDLE publications is shown in Figure 4. China was the most prolific, with 172 publications, including 83 from China mainland, 51 from Hong Kong, 32 from Taiwan, and 6 from Macao. Other countries with at least 15 articles include the US (37), Indonesia (25), Iran (22), Thailand (16), and Turkey (15). Notably, China with all its regions, contributed 52% of the total publications.

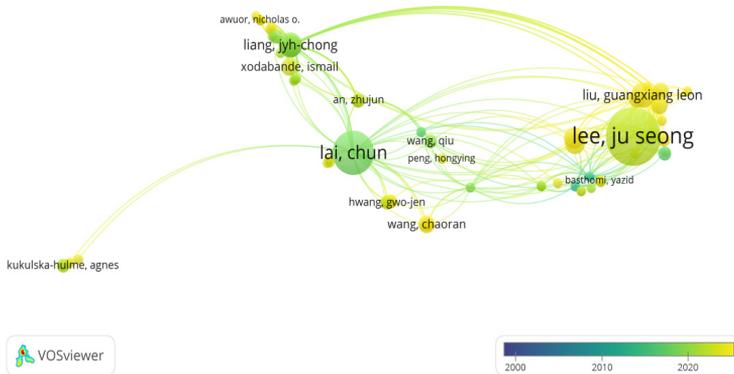


Figure 3. The most productive authors

Number of publications by country

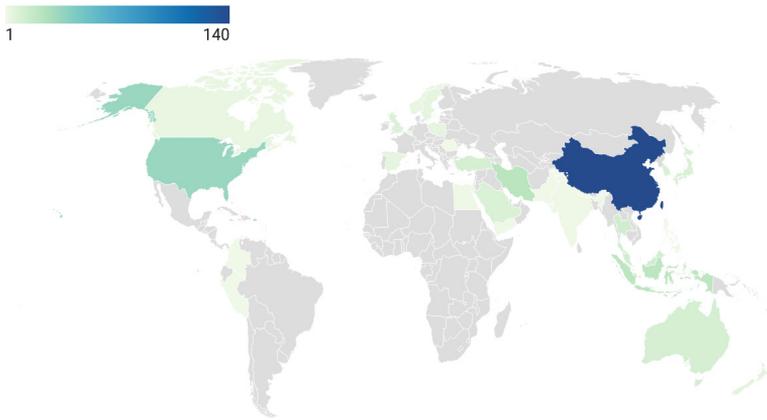


Figure 4. Geographical distribution of publications

Figure 5 presents the six most productive institutions, each with a minimum of three publications. Among these, five are from Chinese institutions, namely the Department of English Language Education, the Department of English, the Faculty of Education, Department of Mathematics and Information Technology, and the Graduate Institute of Digital Learning and Education. The Department of Foreign Languages from Iran also ranks among these leading institutions.

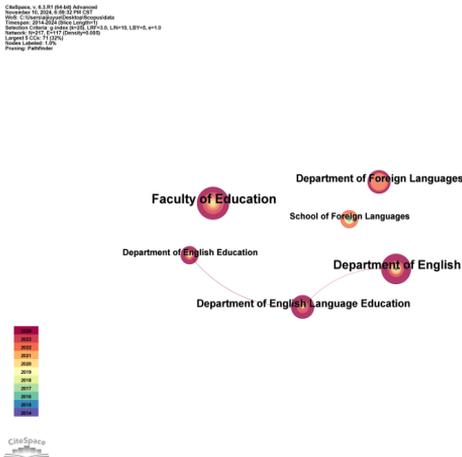


Figure 5. Institutions with a minimum of three publications

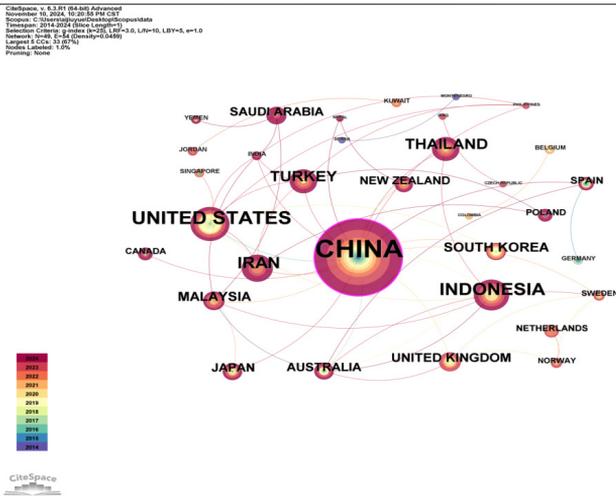


Figure 6. The country co-authorship

Figure 6 presents the graphical representation of the country co-authorship network for research on informal digital learning of English. The size of the nodes reflects the degree centrality, indicating the number of collaborations each country has. The width of the edges denotes the intensity of these collaborations, measured by the volume of co-authored papers. This figure provides a clear view of the leading countries in terms of co-authorship and their collaborative connections. Notably, China demonstrates the most extensive network, collaborating intensively with countries such as Indonesia, the US, Thailand, Malaysia, South Korea, India, Iran, Australia, Japan, the UK, and Canada. The visualisation highlights China’s central role in the field, with a significant portion of its collaborations involving other Asian countries.

Co-occurrence of keywords

The VOSviewer 1.6.20 was used to create a network based on the co-occurrence of keywords in IDLE. Keywords can serve as a good indicator of the trending themes within scientific fields.

From the retrieved documents from the Scopus database with an initial 1021 author keywords were recorded. Figure 7 illustrates the findings of the author keywords analysis with a minimum 4 occurrences. The most commonly used keywords in the published documents were found to be “self-regulated learning”, and “learner autonomy” were observed to be the most frequently used keywords in the published documents, followed by “e-learning”, “informal digital learning of English”, “motivation”, and “students”.

The nodes of the same colour form a cluster. As depicted in Figure 7, each colour corresponds to a specific cluster. The most frequently occurring keywords in each cluster are detailed in Table 5.

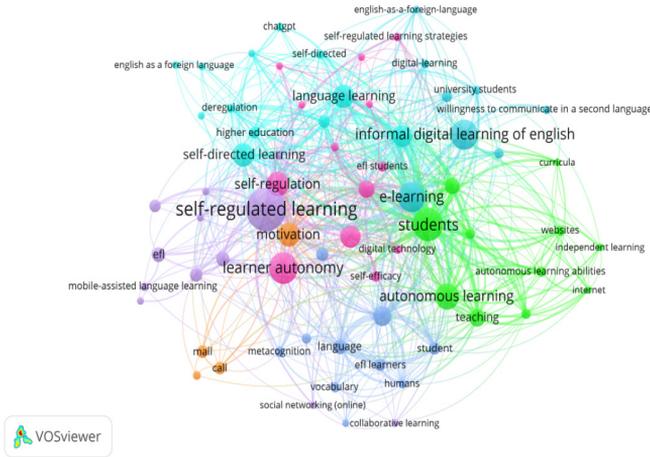


Figure 7. The co-occurrence network of frequent keywords by VOS viewer

Cluster 1 comprises 10 items (22% of the total 45) with keywords such as “informal learning”, “learner autonomy”, “mobile-assisted language learning”, and “smartphones”, indicating the autonomous learning through technology-enhanced IDLE. Cluster 2 comprising 20% of the total 45 items, focuses on integrating technology into English language learning in higher education. CALL, MALL, and virtual reality are discussed for language education. Cluster 3 (20% of the total 45) demonstrates the development of both productive (e.g., writing) and receptive skills (e.g., reading) through IDLE, emphasising the importance of collaboration and self-efficacy. Cluster 4 comprises (17.8% of the total 45) keywords such as “students, e-learning, informal language learning, IDLE, university students” indicating a focus on how university students engage in informal digital language learning environments (IDLE) and e-learning platforms to enhance their language skills. Cluster 5 includes (13.3% of the total 45) keywords like “efl learners”, “social networking (online)”, and “vocabulary learning”, suggesting a focus on the use of social media and online social networking for vocabulary acquisition among EFL learners. Cluster 6 comprises (6.7% of the total 45) keywords such as “efl students”, “english learning”, “motivation”, indicating a focus on the motivational aspects of IDLE.

Table 5. Clusters of author keywords

No	Items (percentage)	Representative keyword item with high occurrence
1	10 (22.2%)	informal learning, learner autonomy, mobile-assisted language learning, out-of-class learning, self-directed learning
2	9 (20%)	call, engagement, english language learning, higher education, mall
3	9 (20%)	collaboration, computer aided instruction, reading comprehension, self-efficacy, writing
4	8 (17.8%)	students, e-learning, informal language learning, IDLE, university students
5	6 (13.3%)	efl learners, social media, social networking (online), vocabulary learning
6	3 (6.7%)	slf students, english learning, motivation

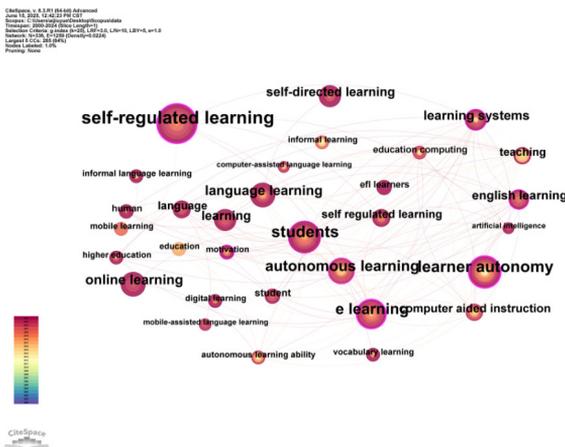


Figure 8. The co-occurrence network of frequent keywords by CiteSpace

To further analyse keyword co-occurrence, CiteSpace was used for visualisation. In the network shown in Figure 8, larger nodes indicate higher keyword frequency. Figure 8 illustrates that the prominent keyword is "self-regulated learning", followed by "students", "learner autonomy", "autonomous learning", "e-learning", "online learning", and "learning systems". Notably, the purple outer rings highlight keywords that remain research hotspots in IDLE, including "self-regulated learning", "learner autonomy", "students", "e-learning", "learning systems", "English learning", and "motivation".

Co-citation of Authors and References

We employed co-citation of authors and references to identify foundational theories. Co-citation examines how often two documents are cited together by other documents, revealing well-established theoretical foundations. Given that co-citation tracks how prior research is jointly referenced (Ferreira, 2018), it is used to address the third research question.

Co-citation of authors

We set a minimum threshold of 20 citations, and 178 authors were analysed. Table 6 presents key authors based on co-citation frequency and total link strength, as well as their contributions. These authors have significantly advanced two major perspectives (1) psychological perspective, including motivation and self-regulation theories, and (2) social cultural perspective.

Table 6. Five authors with highest citations and contributions

Author	C	TLS	Key contributions
Lee Ju Seong	299	13,891	Originated IDLE concept (2018 2019)
Lai Chun	281	10,370	Coined L2 learning beyond the classroom (2015)
Barry Zimmerman	222	7,561	Formulated L2 self-regulation theory (2008)
Phil Benson	187	5,569	Developed learner autonomy framework (2011)
Zoltán Dörnyei	173	6,784	Created L2 Motivational Self System (2005)

Notes: C = Citation; TLS = Total link strength

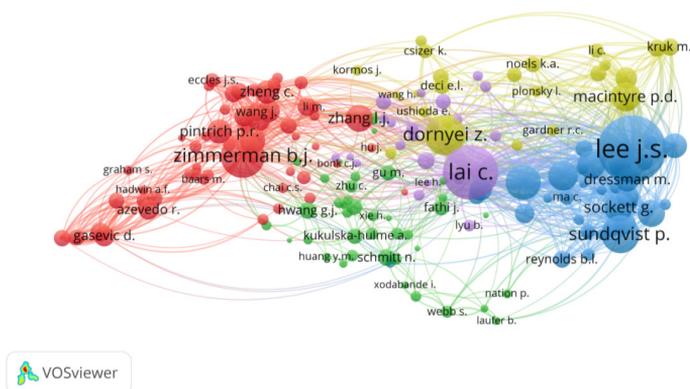


Figure 9. Network of the largest set of connected authors

Create Map

Verify selected cited references

Selected	Cited reference	Citations	Total link strength
<input checked="" type="checkbox"/>	lai c., zhu w., gong g., understanding the quality ...	28	199
<input checked="" type="checkbox"/>	lee j.s., dressman m., when idle hands make an e...	26	179
<input checked="" type="checkbox"/>	lee j.s., drajati n.a., affective variables and inform...	22	166
<input checked="" type="checkbox"/>	sockett g., the online informal learning of english...	24	165
<input checked="" type="checkbox"/>	lee j.s., quantity and diversity of informal digital l...	19	161
<input checked="" type="checkbox"/>	sundqvist p., sylven i.k., extramural english in tea...	18	159
<input checked="" type="checkbox"/>	sundqvist p., wikstrom p., out-of-school digital g...	23	141
<input checked="" type="checkbox"/>	reinders h., benson p., research agenda: languag...	18	135
<input checked="" type="checkbox"/>	sockett g., toffoli d., beyond learner autonomy: a...	20	134
<input checked="" type="checkbox"/>	cole j., vanderplank r., comparing autonomous a...	16	119
<input checked="" type="checkbox"/>	sauro s., zourou k., what are the digital wilds?, la...	12	107
<input checked="" type="checkbox"/>	benson p., language learning and teaching beyo...	16	104
<input checked="" type="checkbox"/>	lee j.s., informal digital learning of english and se...	15	103
<input checked="" type="checkbox"/>	lee j.s., lee k., the role of informal digital learning...	14	99
<input checked="" type="checkbox"/>	chik a., ho j., learn a language for free: recreatio...	11	95
<input checked="" type="checkbox"/>	lai c., gu m., self-regulated out-of-class language...	33	94
<input checked="" type="checkbox"/>	lee j.s., informal digital learning of english: resear...	11	88
<input checked="" type="checkbox"/>	sundqvist p., commercial-off-the-shelf games in t...	10	88

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Figure 10. Co-citation analysis of articles

Figure 9 visualised the co-citation network where each node represents an author and connecting lines and distance demonstrate co-citation relationships (Mas-Tur et al., 2021; Tan, 2022). Figure 9 demonstrates a growing interdisciplinary synthesis in L2 research, integrating psychological constructs, social-cultural learning contexts, and learner autonomy frameworks. This trend reflects a paradigm shift toward ecological models of L2 acquisition, suggesting future theoretical foundations: (1) dynamic interactions between cognitive, metacognitive, technological, and social factors, (2) learner-centred learning processes, and (3) learner autonomy in digital environments.

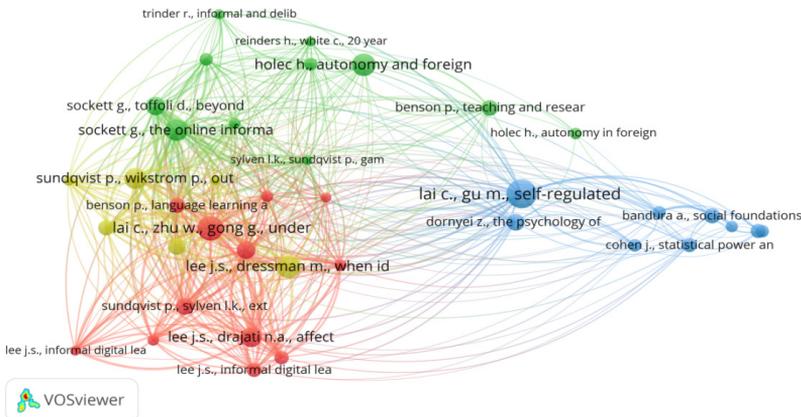


Figure 11. Network of the largest set of connected articles

Co-citation of reference

When analysing the 330 articles, we set the minimum threshold of 10 citations. Of 15229 references, 38 meet the threshold. Figure 10 presents the most co-cited documents.

To better understand this indicator (i.e., co-citation analysis of articles), a network is presented in Figure 11, where the largest set of connected items is presented. Specifically, Figure 10 and Figure 1a showed five most cited references are:

1. Lai, C., Zhu, W., & Gong, G. (2015). Understanding the quality of out-of-class English learning. *TESOL Quarterly*, 49(2), 278–308.
2. Lee, J. S., & Dressman, M. (2018). When IDLE hands make an English workshop: Informal digital learning of English and language proficiency. *TESOL Quarterly*, 52(2), 435–445.
3. Lee, J. S., & Drajadi, N. A. (2019). Affective variables and informal digital learning of English: Keys to willingness to communicate in a second language. *Australasian Journal of Educational Technology*, 35(5), 168–182.
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DISCUSSION

Based on our bibliometric visualisations, this section addresses the three research questions with both depth and breadth.

RQ 1: What journals, publications, researchers, and countries have been most influential in IDLE research?

Our analysis reveals that *Computer Assisted Language Learning* (1,408 citations, 29 articles) and *Language Learning & Technology* (722 citations) are the foremost journals, demonstrating IDLE's strong theoretical and methodological connections to CALL. Notably, publication trends in other journals reveal disciplinary expansion. For instance, *Frontiers in Psychology* (218 citations, 18 articles) reveals a growing attention to affective and cognitive dimensions. *Sustainability* (143 citations, 6 articles) suggests a developing interest in societal impacts on IDLE.

The period (2000–2024) saw exponential growth in IDLE publication, with a particularly sharp rise from 2022 onward. This surge coincides with the advent of generative artificial intelligence (GenAI), suggesting a strong correlation between technological innovation and the expansion of the IDLE research field. Digital technologies like ChatGPT have profoundly transformed L2 acquisition since 2022 (Yang & Li, 2024), suggesting a strong correlation between technological innovation and IDLE research growth. Unlike earlier digital tools, GenAI can act as a dynamic content generator, potentially shifting the focus of IDLE research from learner interaction with static digital content to co-creation with an AI agent. Therefore, the post-2022 growth likely represents not just an increase in volume but a significant theme within IDLE research, driven by the affordances and challenges of generative AI.

We identified Lee (Education University of Hong Kong) as the most prolific IDLE researcher with 17 publications, followed by Lai (University of Hong Kong) with 12 articles. Both scholars, building on CALL research foundations, have pioneered work at the intersection of technology, learning environments, and psychological factors. Lee (2018, 2019) originated *IDLE concept*, while Lai (2015, 2017) introduced the concept of *language learning beyond the classroom*.

Geographically, China accounts for 52% of IDLE publications. While this can be attributed to structural factors like a large population of English learners and national policies promoting educational technology (Liu et al., 2022; Rose et al., 2020), this concentration also presents a risk of geographic bias. The co-authorship network, while showing China's extensive intra-Asian collaboration, simultaneously reveals a relative lack of research hubs in other continents. This raises a critical question for the field: to what extent do the current themes and findings in IDLE literature reflect a globally diverse phenomenon? The overwhelming focus on one geographic area potentially limiting the diversity of cultural and pedagogical perspectives represented in the literature.

RQ2: What are the predominant research themes in IDLE studies?

Our co-occurrence analysis identified six predominant thematic clusters in IDLE research, revealing a clear evolution from an early focus on structured digital tools to a focus on learner-driven processes. Early IDLE research (pre-2016) primarily examined structured computer-assisted instruction (e.g., MALL, CALL), reflecting an initial grounding in formal learning contexts. Post-2016, the field shifted toward self-regulated learning, evidenced by emerging keywords like *online learning*, *e-learning*, and *mobile learning*. This evolution crystallised into six distinct thematic clusters. Cluster 1 “autonomous digital learning” (22.2%) focuses on mobile technologies enabling learning beyond the classroom, Cluster 2 “technology engagement” (20%) examines CALL in formal higher education, Cluster 3 “collaboration and self-efficacy” (20%) researches

the social and psychological aspects of CALL, Cluster 4 “university learners” (17.8%) represents the dominant population studied, Cluster 5 “social media” (13.3%) concerns digital resources for L2 acquisition, and Cluster 6 “motivation” (6.7%) investigates psychological factors in informal L2 learning.

To move beyond simply mapping these themes, we analysed how highly cited publications have actively advanced these conceptual domains. The clusters are not merely passive categories but represent research fronts that have been substantively defined by influential studies. For instance, the concept of autonomous digital learning (Cluster 1) was advanced by foundational work such as Lai and Gu’s (2011) model of self-regulated learning with technology and Chik’s (2014) investigation of autonomy and community in digital gaming. These studies did not just align with the cluster; they provided the empirical and theoretical groundwork that established learner autonomy as a core of IDLE, distinguishing it from CALL.

Similarly, the technology engagement cluster (Cluster 2) was shaped by studies that identified both the potentials and constraints of integrating technology in formal settings. Chen and Hsu’s (2020) research on VR and Lai’s (2015) work on teacher influence provided critical insights into the complex interplay between digital tools, pedagogical support, and institutional barriers.

The progression of other clusters can likewise be traced to pivotal contributions. The focus on social and psychological aspects (Clusters 3 and 6) was empirically fortified by Botero et al.’s (2019) exploration of motivation in mobile-assisted learning and Kondo et al.’s (2012) findings on self-efficacy. Meanwhile, Rosell-Aguilar’s (2018) user evaluation of language apps played a key role in crystallising the research domain around social media and vocabulary learning (Cluster 5). Therefore, the co-occurrence clusters and the highly cited literature are mutually illuminating. The clusters reveal the thematic structure of the field, while the influential publications illustrate the intellectual forces that drove the formation and evolution of these themes.

RQ 3: In what ways does informal digital learning of English (IDLE) extend beyond Computer Assisted Language Learning (CALL)?

We identified *Computer Assisted Language Learning* (1,408 citations) as the most influential journal on IDLE research, indicating that the foundational role of CALL to IDLE. While both IDLE and CALL concern technology-mediated L2 acquisition (Guo & Lee, 2023; Mohsen et al., 2024; Soyoof et al., 2023), our analysis reveals a more complex reality: IDLE has not merely branched off from CALL, but has established itself as a unique intellectual structure. The divergence is evident across four aspects as follows:

- 1. From Learning Tool To Learner Ecosystem:** CALL introduced nearly three decades ago (Levy, 1997), is defined as “*the search for and study of applications of the computer in language teaching and learning*” (p.1), focusing on the computer as a tool within instruction. In contrast, clusters like “self-regulated learning”, “learner autonomy”, “e-learning”, and “informal digital learning of English” demonstrate that IDLE research conceptualises learning not as a tool-based application, but as an organic byproduct of personal digital experience.
- 2. Beyond the Classroom:** The data confirms that CALL research predominantly examines formal settings. Conversely, IDLE operates in informal digital environments (e.g., social media, streaming platforms), where learning is autonomous, incidental and interest-driven (Lee, 2019; Sundqvist & Sylvé, 2016). This represents a fundamental shift from structured, in-class instruction to learning embedded within interest-driven digital spaces.
- 3. Theoretical Advancements:** While CALL research is primarily grounded in Second Language Acquisition (SLA) theories (Chapelle, 2009), our co-citation and journal analysis reveal that IDLE is inherently interdisciplinary. The significant influence of journals like *Frontiers in Psychology* and the distinct “motivation” cluster provide empirical evidence that IDLE is theoretically pluralistic. This interdisciplinary foundation enables IDLE to examine the complex interactions among digital environments, learner psychology, and L2 acquisition that traditional CALL frameworks often overlook.
- 4. Pedagogical Reorientation: Process Over Product:** The pedagogical focus of CALL is on structured design and measurable L2 outcomes. Clusters such as “learner autonomy” and “self-regulated learning” reveal a scholarly interest in how learners independently orchestrate their development, navigate digital resources, and sustain motivation without formal guidance.

CONCLUSION

This bibliometric review maps IDLE’s research landscape from 2000–2024, revealing a strong correlation between technologies and L2 acquisition, a need for broader regional representation, and the ecosystemic nature for L2 acquisition in digital contexts. The evolution from CALL to IDLE further evidences future research should consider learner autonomy, psychological factors, social supports, and technological innovations. While these elements represent critical considerations, they should not be viewed as exhaustive. Given the dynamic and complex nature of language learning, IDLE researchers should adopt a broader conceptual framework that extends beyond traditional CALL paradigms.

There are still limitations of the review, which provides important context for its findings and direct avenues for future inquiry. The exclusive reliance on Scopus, while a common and justified choice for its breadth in social sciences, inherently means that some relevant literature indexed in other databases (e.g., Web of Science, ERIC) may have been excluded. More critically, our finding of geographic concentration in China is not just a result but is also potentially compounded by this database selection, as regional journals not indexed in Scopus are absent from our analysis. Consequently, the geographic and linguistic biases we identify are likely even more pronounced than our data suggests. Building on our findings, we propose the following suggestions for future research:

1. Longitudinal bibliometric tracking: Conduct follow-up analyses to track the evolution of AI-driven IDLE post-2022, specifically examining the thematic shift prompted by generative AI tools like ChatGPT and their integration into informal learning environments.
2. Qualitative and mixed-methods inquiries: employ qualitative studies to deeply explore the learner experiences, strategies, and socio-affective challenges within specific IDLE contexts.
3. Expanding geographical scope: Actively investigate IDLE practices in underrepresented regions (e.g., South America, Africa, and the Middle East) to develop a more globally representative understanding of how diverse cultural and socioeconomic factors shape informal digital learning.

Despite its limitations, our study provides a comprehensive presentation and analysis of current research. The implications for educators include adopting a pedagogical approach that accommodates learner diversity, IDLE experience, and responds to the evolving digital landscape to enhance IDLE practices and achieve effective educational outcomes.

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CONFLICT OF INTEREST

No competing interests exist.

DATA AVAILABILITY

The data and material can be used by any reader who can access to the publication.

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CONTRIBUTIONS OF AUTHORS

Aiju Liu: Conceptualisation, methodology, and writing original draft.

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