Chatbots and EFL Learning: A Systematic Review

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Abstract

Chatbots have been increasingly playing a greater role in English as a foreign language education, offering learners the opportunity to practise with a conversational agent at any time and in different contexts. To grasp how this field has developed and identify emerging trends and opportunities, we conducted a systematic bibliometric analysis of research on chatbots in English language learning from 2006 to 2023. The analysis highlights the increasing importance of Large Language Models in language learning, exploring their potential to overcome previous limitations of chatbot technology. The implications of these findings for future research are discussed, particularly the potential for chatbot designs tailored to the specific needs of English language learners.

Keywords

Chatbots, EFL, bibliometric analysis, DB-CALL, LLM, conversational agent, dialogue system

1. Introduction

Natural and flowing dialogue is an essential aspect of communication and creating shared understanding. Simulating dialogue has been one of the goals of researchers since the first chatbot, ELIZA, was developed more than 50 years ago [1]. Chatbots have exploded in popularity over recent decades in numerous fields; including customer service, gaming, healthcare, and education [2]. In the context of second language acquisition, practising dialogue is imperative for developing natural language skills and communication competence [3]. Conversing with chatbots is one of the closest approximations there is of conversation with real people. As native and proficient speakers for conversation practice can be challenging to access due to geographical, time, and resource constraints, chatbots provide an alternative for practice in a given target language. Also known as dialogue-based computer-assisted language learning (DB-CALL), chatbots have shown to have a significant positive effect on the development of second language proficiency [4]–[6]. In learning English as a foreign language (EFL), chatbots can be used for conversation practice, roleplay, answering language related questions, conducting assessments, and providing feedback [7]. Huang et al. [7] identifies three benefits of using chatbots for language learning: anytime anywhere availability; broad language knowledge; "tireless assistants" when compared to human counterparts. However, several limitations of chatbots have also been identified [7], [8]: novelty effects - heightened initial interest, enthusiasm, and engagement due to the chatbots newness and learner curiosity; formulaic and predictable responses [9]; lack of personalisation to individual learner needs and localisation issues [10]; lack of contextual understanding; and technological limitations where unlike humans, chatbots can be more sensitive to erroneous input (e.g. spelling mistakes). They may also find it difficult to maintain conversational consistency or stay "on topic" [11].

As there have been many recent advances in chatbot methods and technology, this paper presents a bibliometric analysis of peer-reviewed research articles from the Web of Science database on chatbots in the context of second language acquisition. Specifically, this paper seeks to answer the following research questions (RQs):

1. What are the publication trends in research on chatbots and EFL learning?
2. Who are the key authors and research groups working on and researching chatbots for EFL learning?

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3. What are the milestone articles in the field of chatbots for EFL learning?
4. What are the key themes - current and emerging, challenges, and future directions of chatbot use in EFL learning?

2. Related work

Several literature reviews and meta-analyses have been conducted in recent years. Pérez, Daradoumis, and Puig [12] reviewed the literature on chatbots in the field of education. They found that chatbots are regularly used and effective in education to assist and teach in a large variety of educational settings, including supporting learning for minority groups and learners with disabilities. Wollny et al. [13] specifically focused on chatbot applications and their pedagogical roles, such as: learning, assisting, and mentoring, with four main objectives: skill Improvement, efficiency of education, students' motivation, and availability of education. Kuhail et al. [14] reviewed 36 articles from 2011-2021 and found that over a third of chatbots were for computer science education. Very few chatbots were used for scaffolding, as motivational agents, and only two chatbots acted as teachable agents where the learners were tasked with teaching the chatbot. Most chatbots provided chatbot-driven conversation within a narrow knowledge domain, and very few allowed user-driven conversations due to the technical complexity of an open-ended design. However, most experimental studies showed a statistically significant improvement in "learning and student satisfaction" (p. 1007).

Regarding language learning, Bibauw et al. [5] conducted a meta-analysis of 17 studies on dialogue-based CALL which showed a significant medium effect of interaction with chatbots on target language proficiency, and systems that provided corrective feedback were particularly effective. Zhai [15] reviewed 28 articles published in the last 10 years on AI-based dialogue systems for improving the EFL interactional competence in university students. They identified six dimensions, made up of 25 sub-dimensions, that influence the application of chatbots for learning English: technological integration, task designs, student engagement, learning objectives, technological limitations, and the novelty effect.

In this paper, we present a systematic bibliometric analysis of the research in chatbots and EFL learning focusing on recent important advances such as Large Language Models (LLMs), with discussion on themes and potential gaps in the literature, as future implications for the field. Advancements in LLMs include language understanding and production by machines, and could provide solutions to some of the technical obstacles that earlier iterations of chatbot technology encountered. As many reviews have been published pre-LLMs, this study seeks to explore the potential of LLMs in this field, and suggest opportunities and potential challenges for the future.

3. Methodology

A bibliometric analysis was conducted to survey and help understand the trends occurring in chatbot usage in English language acquisition. Bibliometric analysis is an established technique for systematically quantifying the academic literature on a given topic in a variety of academic disciplines [16]. These analyses are often used to elucidate emerging trends, analyse article performance and patterns of collaboration, and also identify potential gaps in the literature [17].

The literature search was conducted in early December of 2023. Biblioshiny, web interface for the bibliometrix RStudio package, was utilised for the bibliometric analysis [18]. Relevant keywords were collaboratively chosen by the authors to include all articles that discuss chatbot usage in English language learning. The authors wanted to include all articles at the intersection of conversation agents and English language learning. These keywords include common synonyms for each concept, without introducing excessive unrelated material. After several iterations, the final search query was the following: `(TS=(chatbot*) OR TS=(conversation* agent) OR TS=("dialogue system")) AND (TS=(language learn*) OR TS=(language acqui*)) AND (TS=(English) OR TS=(ESL) OR TS=(ESOL) OR TS=(EFL) OR TS=(EAL))`. A search was conducted on Web of Science (WoS), a platform that provides access to the metadata of high quality academic journals and conference proceedings via multiple databases. This database was chosen for its interdisciplinary coverage providing a comprehensive overview of the literature spanning multiple disciplines. WoS is also well-known for the quality of its sources, indexing peer-reviewed scholarly literature from reputable journals [19]. A total of 182 records were returned and all fields were exported for analysis.

To ensure a systematic and transparent review, the PRISMA inclusion/exclusion process was utilised [20], as shown in Figure 1. PRISMA is a widely recognised method for reporting systematic reviews and meta-analyses. Of the total 182 records, one was a duplicate, and an additional 81 were excluded after review. Articles were excluded if they were not related to chatbots, language learning, or not relevant to either of these. Reviews and meta-analyses were also excluded. A dual-reviewer approach was employed for the article selection. Initially, two researchers independently conducted a blind review of the article titles and abstracts. This independent process ensured that each researcher's evaluation was not biassed by the other. Following the independent review phase, the two researchers convened to compare and discuss their findings. There was 98% agreement on which records should be included. Full texts of the articles in question were retrieved and more thoroughly reviewed until agreement could be achieved. Various meta data of the 100 articles is shown in Table 1.

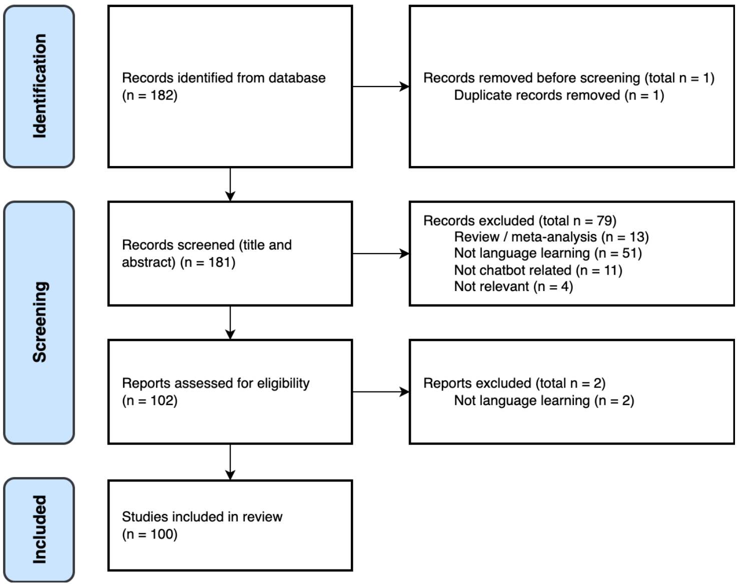

Figure 1: PRISMA flow diagram of the review inclusion process

Table 1
Included article main information

Bibliometric Indicator	Value
Timespan	2006:2023
Unique sources (Journals, Books, etc)	76
Total documents	100
Annual growth rate %	11.38
Document average age	4.18
Average citations per document	9.87
References	3383
Keywords	559
Total unique authors	248

4. Results

The following section provides the results of the bibliometric analysis and aims to answer RQ1-3. Table 2 displays the top five journals that have published research articles on chatbots and EFL learning. Eight articles were published in CALL, a high-quality and prominent interdisciplinary journal in the field of language education technology. Notably, articles on this topic are being published in a wide variety of sources.

Table 2
Most relevant publication sources

Publication Source	Number of documents
Computer Assisted Language Learning	8
Interactive Learning Environments	5
Applied Sciences-Basel	3
British Journal of Educational Technology	3
Education and Information Technologies	3

Table 3 and Figure 2 show the publication and citation trends for the ten most industrious countries. Recently, China has shown notable productivity, which may be attributed to changes in government policy following the international UNESCO conference held in China. This event culminated in the adoption of the 'Beijing Consensus on Artificial Intelligence and Education' [21], a framework of guidelines and recommendations designed to maximise the use of AI in education." Figure 3 is cumulative and is limited to the past ten years to more clearly highlight the recent uptick in research activity in this space. Globally, research output has increased more than fivefold in the last three years.

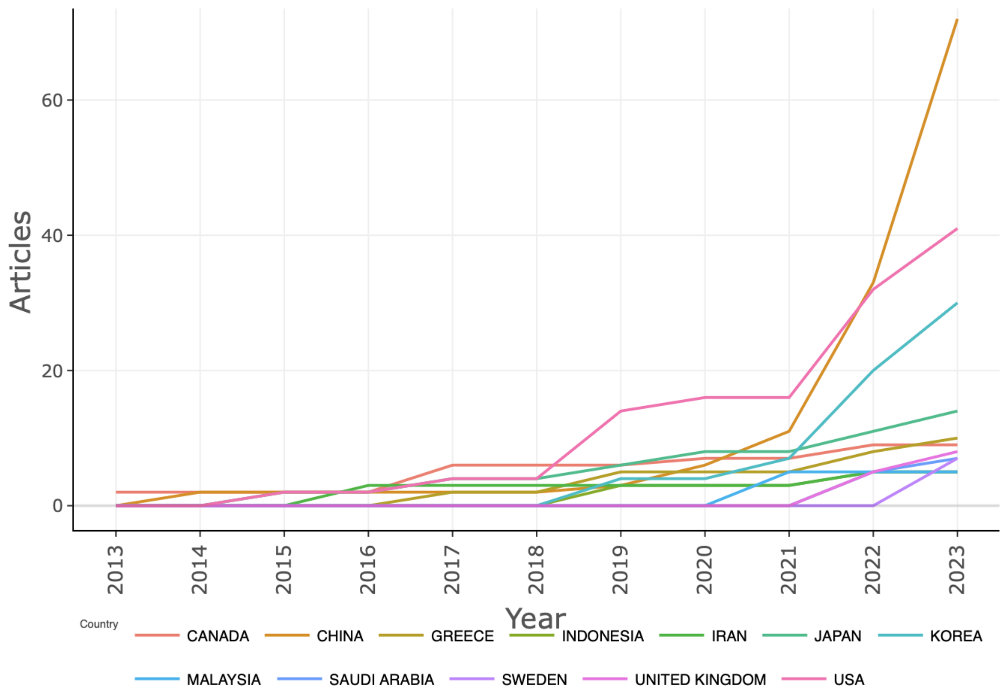

Figure 2: Article publication over time by country (2013 - 2023)

Table 3
Top 10 cited countries and their article publication frequency (2006 - 2023)

Country	TC	Article Production Frequency
China	314	90
Japan	178	18
USA	101	48
Korea	84	30
Canada	61	9
Iran	53	5
Belgium	40	4
Vietnam	32	2
Greece	26	10
UK	24	10

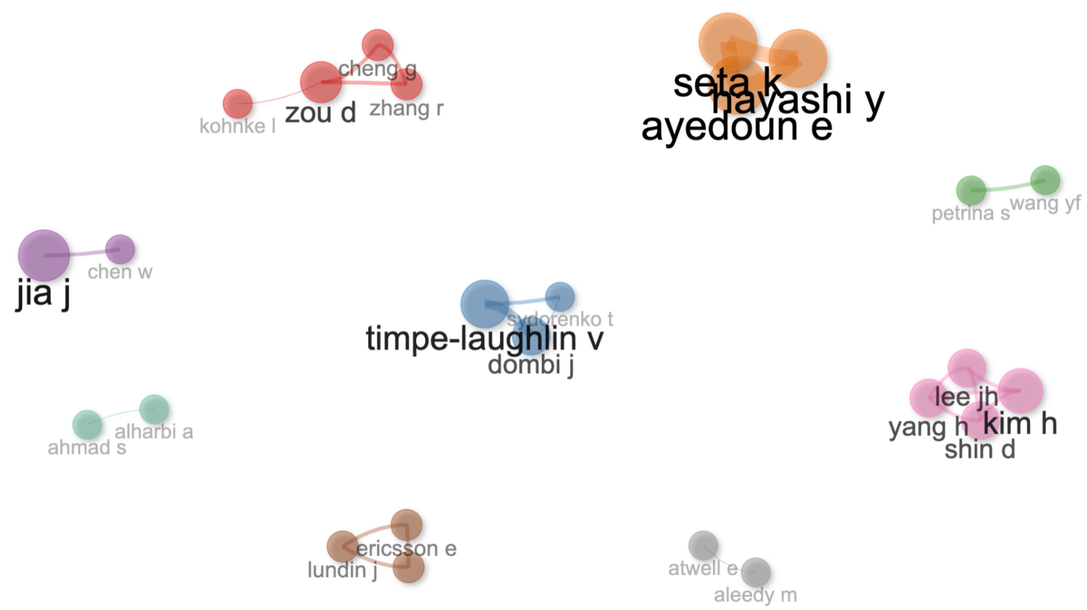

Figure 3: Collaboration network

To answer RQ2, a collaboration network was generated to analyse the co-authorship patterns within the dataset. This visualises the connections between authors based on their shared publications. As illustrated in Figure 3, it is possible to identify several key research collaborations among these authors.

To answer RQ3, citations were examined more closely. In this dataset, the article by Fryer and Carpenter [22] is the most cited work by far, as shown in Figure 4 and Table 4. This prominence is probably because it is one of the earliest studies to use Jabberwacky, a pioneering chatbot that was a precursor to Cleverbot. Rollo Carpenter, one of the authors of this paper, developed Jabberwacky. This chatbot was innovative in learning new responses and contexts from live user interactions, unlike earlier chatbots that relied on fixed databases [23]. Jabberwacky's advanced capabilities led to it winning the Loebner Prize, a yearly AI competition where chatbots are judged for their human-like qualities in a Turing test-like scenario.

Table 4
Top 5 global cited documents (2006 - 2023)

Article	Total	TC / year	Normalised
FRYER L, 2006, Lang. Learn. & Technol.	120	6.32	3.08
JIA J, 2009, Knowl.-BASED Syst.	51	3.19	2.28
BIBAUW S, 2019, Comput. Assist. Lang. Learn.	40	6.67	2.82
WANG YF, 2017, Br. J. Educ. Technol.	39	4.88	2.89
TAI TY, 2023, Interact. Learn. Environ.	39	19.50	8.26

The article by Tai and Chen [24] was actually published online in 2020, so has had some time to accumulate references. It describes a study on adolescent language learning with Google Assistant. The researchers found that when interacting with the intelligent assistant via speech, learners had increased communicative confidence and reduced speaking anxiety.

In 2019, Bibauw et al. [25] conducted one of the most comprehensive systematic reviews of the literature on DB-CALL to date. From 343 publications, 96 chatbots systems were identified; their interactional, instructional, and technological traits were analysed. They summarised empirical studies on their effectiveness in the context of SLA and proposed several avenues for future research.

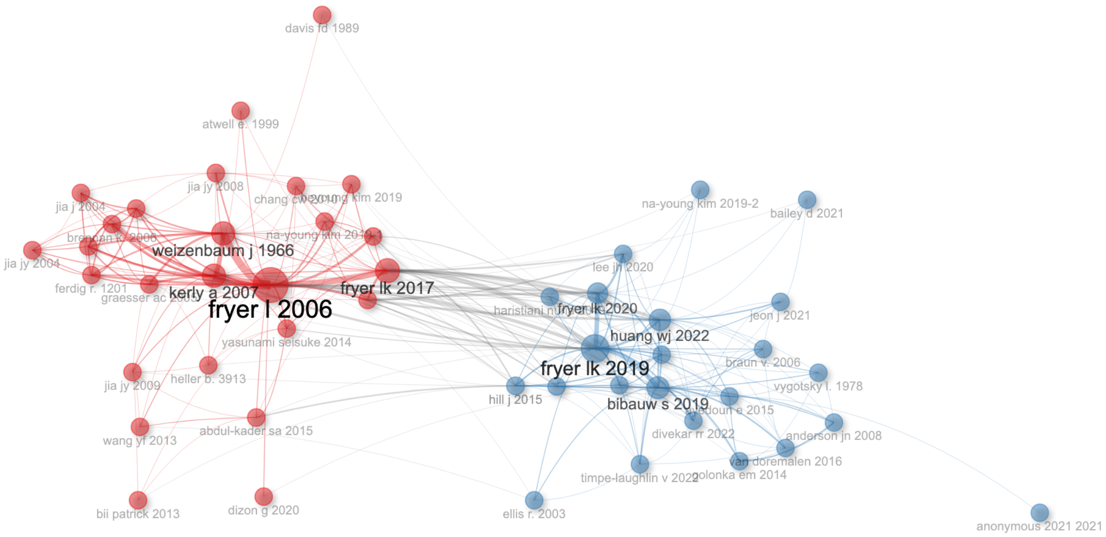

Figure 4: Co-citation network (larger font and node size indicate more citations)

To answer RQ4, an analysis was conducted on the keywords provided by each article's author(s).

Figure 5 shows the cumulative frequency from 2006 until 2023 of the top 15 keywords in the dataset. The *chatbot* keyword in this dataset has exploded in popularity, with a total of 35 cumulative occurrences; 24 of those since 2021. The next most common keyword is *artificial intelligence* with twenty cumulative occurrences.

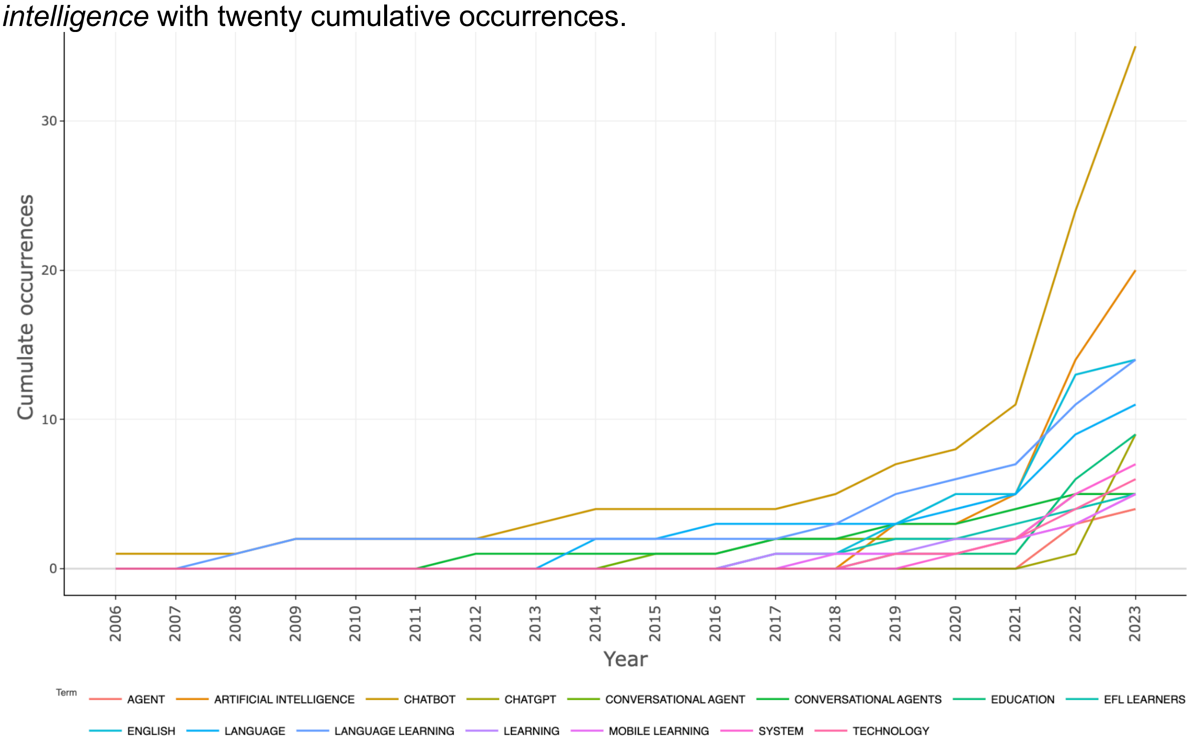

Figure 5: Cumulative word frequency over time of top 15 keywords

Figure 6 visualises the landscape of research within the field of chatbots for EFL learning as a thematic map. The horizontal axis represents the centrality of themes to the field, with themes towards the right being more relevant. The vertical axis indicates how developed each theme is, with higher positions showing greater maturity in research within the dataset. *Chatbot* and *artificial intelligence* are basic themes, suggesting they are very relevant yet still developing within the field. Predictably, the map also identifies *English*, *conversational agents*, and *learners* as motor themes, indicating they are both central and highly developed in the research literature. Niche themes such as *English writing* are well-developed but less central. *Dialogue systems* is situated in the Emerging or Declining Themes quadrant, perhaps as the term itself is losing favour.

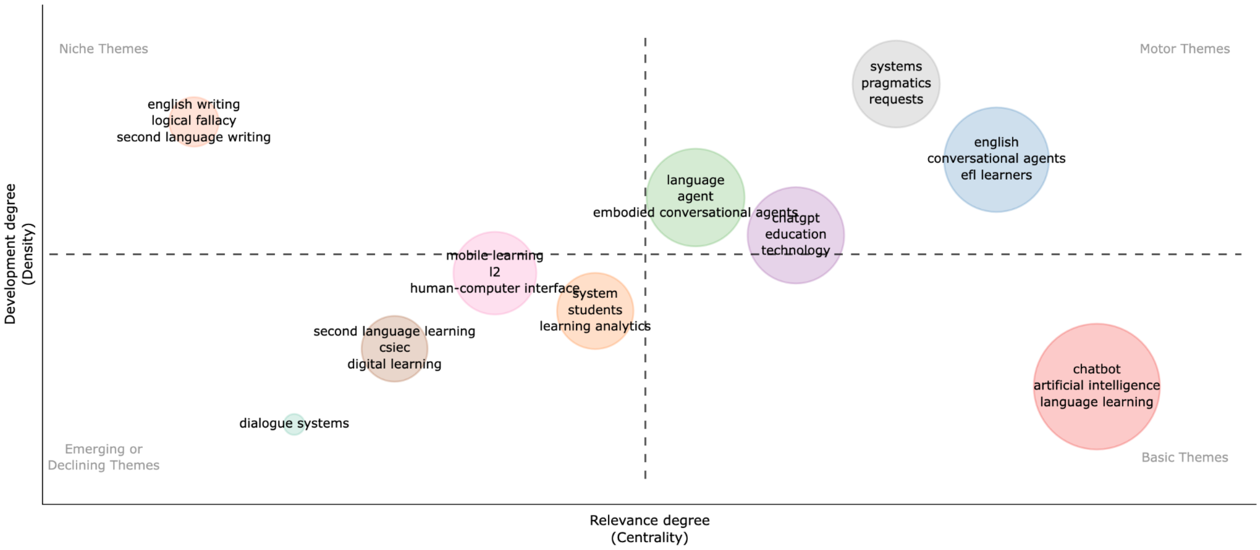

Figure 6: Thematic map of current dataset: 2006 - 2023

5. Discussion

LLMs like OpenAI's GPTs are transforming the landscape of chatbots and language learning in general [26]. Utilising their capabilities in natural language processing, advanced dialogue comprehension and generation, and personalised feedback, LLMs have the potential to address some of the challenges inherent in traditional chatbots and improve learning outcomes.

LLMs such as ChatGPT have mainly been applied to language learning as a generic support tool, with recent research focusing on the effectiveness and affordances as a learning tool [27]–[29], and perceived usefulness as a learning tool by students [30], [31]. Aspects of previous research that have investigated integrating LLMs have been limited to the effectiveness for generating dialogue materials as a chatbot in EFL [32], comparative writing evaluation with EFL learners [33], and employing it as a tool for automated writing feedback [34]. As suggested by Fryer and Carpenter [22] in their seminal work, bots are usually developed to target native speakers and therefore often only effectively cater to the needs of intermediate to advanced learners. While previous research has often leveraged that LLM-generated artefacts have strong resemblances to those of native speakers, to the best of the author's knowledge there is no research into tailoring LLM output to meet the specific needs of EFL learners.

Hence, more research needs to be conducted in this area. Depending on one's theoretical and pedagogical positioning, an ideal language learning chatbot will: match a learners language level for each language skill; simulate real-life language and conversation skills; detect, identify, and correct errors when appropriate for optimal learning; provide diverse, appropriate, and personalised content; provide a system for tracking progress; identifying needs, strengths, and weaknesses; foster motivation in learners [35]. This paper proposes the development of an English language learning chatbot using two techniques to strive for the ideal described above:

1. Building on the work of Baek et al. [36] where they enhance an LLM's ability to respond without additional model training, an LLM could be pre-prompted with pertinent information about a learner and their language learning needs.
2. Data about the learner - their progress, language learning needs etc. - would need to be stored and processed to provide the chatbot with relevant pre-prompting. Flanagan et al. [37] have already made much progress in this space with their work on knowledge map creation for modelling learning behaviours in digital learning environments.

In Figure 7 we propose a possible chatbot design utilising these two techniques. The learner converses with an LLM through a personalised and context-aware *prompt constructor*. The prompt is generated based on knowledge from the learning content as given provided by the teacher or course guidelines, chatbot parameters such as explicit instructions on how to respond to questions to enhance learning, and learner data, such as: English level, past session data and learner models based on interaction with other learning systems.

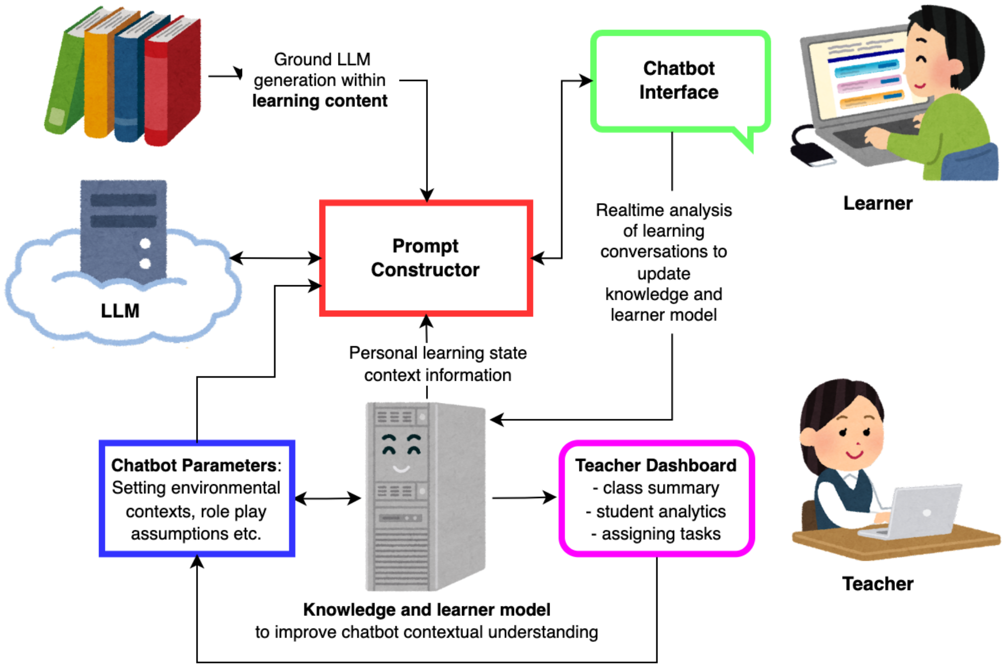

Figure 7: Possible configuration of LLM-based chatbot to support language learning

In conclusion, this paper has systematically analysed the intersection between chatbots and EFL learning in the literature. Specifically, publication trends were examined. Key authors, research groups, and journals were identified, and milestone articles in the field were reviewed. Key themes in the space were also investigated, illustrating the recent growth in LLM-based chatbot technology such as ChatGPT in the literature. The advent of LLMs marks a groundbreaking advancement in this field, offering more natural context-aware interactions. Future research should focus on tailoring LLMs to meet specific needs of language learners, considering aspects like language level matching and personalised content. One possible configuration for this is described for the wider research community to discuss. As chatbots become more integrated into language learning and educational programmes, they hold the potential to enhance how English is taught and learned, making language education more accessible, engaging, and effective.

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