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Current Trend of AI in Higher Education Self-Directed ESL/EFL: An activity theory approach

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Abstract
This review adapts Engeström's (1987) expanded Activity Theory to investigate current trends and the pedagogical impact of AI in self-directed ESL/EFL within higher education. The review analysed 76 empirical studies from Scopus, Web of Science, and Education Research Complete@EBSCOhost, selected using PRISMA 2020. Findings reveal a sharp increase in AI-supported self-directed ESL/EFL research from 2023 onward. AI-powered chatbots, particularly ChatGPT, dominate usage. Tools like Duolingo, Automatic Speech Recognition (ASR), Automated Writing Evaluation (AWE), and translation tools enhance learners' learning across diverse contexts. Effectiveness assessments consistently indicate neutral to positive perceptions, underscoring the contextual value of AI in promoting self-directed ESL/EFL.

Keywords: Artificial intelligence; active theory; English; self-directed

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1.0 Introduction

Recently, Artificial intelligence (AI) has surged to the forefront of educational technology, eclipsing other digital innovations as the most rapidly embraced force reshaping learning worldwide. According to the 2025 AI Index Annual Report (Maslej et al., 2025), public sentiment toward AI is shifting positively. An Ipsos survey across 26 countries revealed an increase in those who view AI as more helpful than harmful, from 52% in 2022 to 55% in 2024. This growing trust lays fertile ground for AI's deep integration into higher education. Around the globe, universities are no longer merely experimenting; they are embedding AI to redefine teaching methodologies, learning experiences, and campus operations. The rise of technology, particularly AI-driven learning environments, underscores the importance of self-directed learning among ESL/EFL learners, as success depends not only on classroom instruction but also on their active engagement in additional practice beyond class through technological resources (Haidari et al., 2019).

At the heart of this shift are AI-powered tools that empower learners, fostering deeper engagement, strengthening collaboration, and providing personalised feedback to support individual learning progress. Within the AI-driven context, ESL/EFL learners' self-directed roles in self-regulation and emotional engagement are strengthened, highlighting AI's significant potential to advance their productive language skills (Jeon, 2025). As a result, learners' gains not just in academic performance, but also in confidence, creativity and self-direction, attribute vital for thriving in diverse, multilingual environments. Hence, this study aimed at investigating the trends in AI-

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supported self-directed ESL/EFL learning in higher education, identifies the most prominent tools and their effectiveness; to demonstrate how AI-driven language technologies empower learners to overcome linguistic barriers and engage across cultures.

2.0 Literature Review

Within the specific domain of ESL/EFL, research points to AI's effectiveness in fostering student proficiency across diverse linguistic skills. Quan's (2024) review documents improvements in speaking, vocabulary, grammar, and comprehension, while Lin (2023) affirms AI's role in motivating learners to take ownership of their learning processes. Earlier reviews primarily emphasised the connections between AI and ESL/EFL and their overall impacts, yet they did not explore the emerging trends or specific applications of AI within self-directed learning in these contexts—an essential aspect of AI-enabled autonomous study, thus revealing a clear research gap to be addressed by this study.

Activity Theory provides a nuanced, critical lens for examining the human-technology relationship. However, while AI tools hold promise, content accuracy continues to pose a challenge in leveraging AI to support self-directed learning environments. Hazaymeh et al. (2024) and Yang (2024) note that AI frequently struggles to convey cultural nuances and often defaults to overly literal translations, which can hinder nuanced language development. Moreover, since sustained motivation is vital for learner autonomy and continued progress, the limited influence of AI on motivating learners remains a significant concern. These limitations are particularly problematic in self-directed learning contexts, where learners rely on accurate and context-sensitive input. Building on prior review conducted by Liang et al. (2021) and Yang and Kyun (2022), which applied Activity Theory to examine human-technology interaction and AI-supported language learning. Activity Theory rarely places learner autonomy at the core of its evolving, tool-mediated activity systems. Hence, this study advances the discourse by addressing the gap through a focus on self-directed ESL/EFL learning in higher education.

3.0 Theoretical Framework

This review adapted Engeström's (1987) expanded Activity Theory, which is visually represented by a triangular framework encompassing the subject, object, tools, rules, division of labour, and community, culminating in observable outcomes. According to Fig.1, this review applies Activity Theory by positioning ESL/EFL learners as active subjects who engage AI tools to transform their learning practices. "Enhancing self-directed language learning" is the object mediated through AI tools, which redefine the learner-goal relationship. In complex environments, multiple interconnected and evolving activities often coexist, collectively forming an integrated system of actions and interactions. To that note, the community, including learners and instructors, influences which and how AI tools are adopted in ESL/EFL contexts. Rules such as pedagogical norms shape consistent self-directed learning practices. The division of labour distinguishes key roles, such as learners as agents, instructors as facilitators, and developers as tool creators supporting language goals. Finally, the outcome validates the efficacy of AI integration in ESL/EFL contexts, offering actionable insights to enhance self-directed language learning practices.

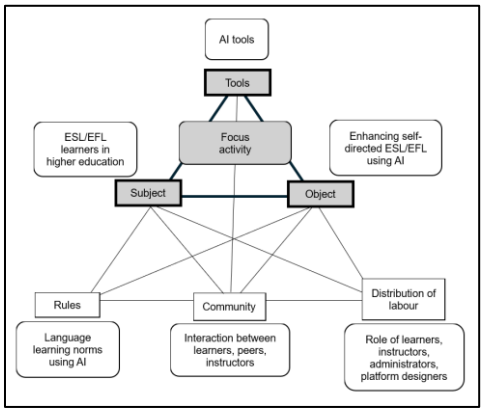

Fig. 1: Activity Theory
(Source: adapted from Engeström (1987))

Through the lens of Activity Theory, the objectives of this study are to analyse current research trends, identify the most prominent AI tools and their effectiveness. In pursuit of these objectives, the review addresses the following research questions:

1. What research trends are utilised in AI-supported self-directed ESL/EFL in higher education?
2. Which AI tools are currently most prominent in facilitating self-directed ESL/EFL learning in higher education?
3. How effective are these AI tools in enhancing learners' self-directed learning skills in ESL/EFL contexts?

4.0 Methodology

4.1 Study selection and inclusion/exclusion criteria

This review conducted a systematic search across three databases: Scopus, Web of Science (WoS), and Education Research Complete@EBSCOhost. Search queries combined keyword sets using Boolean operators, applying "OR" within related terms and

"AND" across distinct categories; resulting in the search configuration: "self-directed" AND "technology OR AI" AND "ESL OR EFL". The distinction between ESL and EFL varies geographically. Despite this distinction, literature often uses these terms interchangeably, and therefore, both were included to avoid unnecessary exclusions. This systematic literature review follows the structured PRISMA 2020 guidelines (Fig.2) that minimise bias and strengthens the reliability of findings, especially in identifying gaps in the intersection of AI and self-directed ESL/EFL, and establish a rigorous foundation for advancing both theory and practice. The process was guided by predefined inclusion and exclusion criteria, as summarised in Table 1.

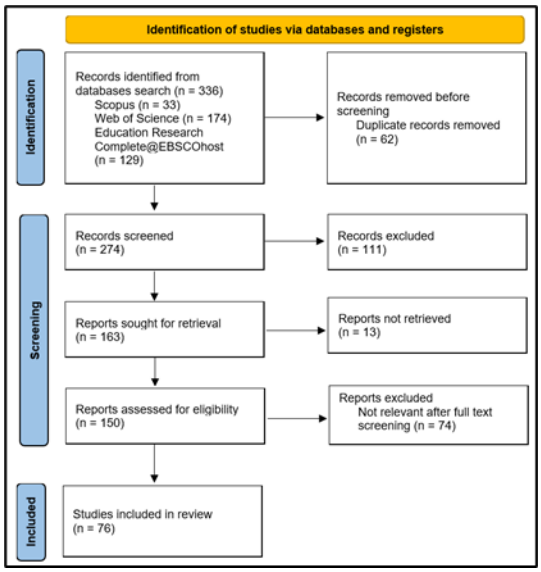

Fig. 2: PRISMA 2020 flow diagram
(Source: adapted from Page et al. (2021))

Table 1. Inclusion / exclusion criteria

Criteria	Inclusion	Exclusion
Time frame	Publications between 2020 to the first Quarter of 2025.	Publications before 2020 and after 2025.
Peer review	Peer-reviewed original research articles that are published in scholarly journals.	(i) Publications that have not undergone peer review. (ii) Studies published as a proceeding of a conference, a dissertation, an editorial, a note, a book, a book chapter, a letter, a review, an article in newspaper, and an article in magazine.
Language	Articles published in English.	Articles published in languages other than English.
Field of empirical research	(1) Empirical research in the field of ESL/EFL. (2) Empirical research on ESL/EFL learners' self-directed learning. (3) Empirical research investigating the role of AI or non-AI tools in facilitating self-directed learning among ESL/EFL learners.	(i) Publications that do not report an empirical study. (ii) Empirical studies that are not about ESL/EFL. (iii) Empirical studies that are not related to self-directed learning of ESL/EFL learners. (iv) Empirical studies that do not report ESL/EFL self-directed learning with the implementation of AI or non-AI tools. (v) Studies focusing on ESL/EFL at preschool, elementary, secondary, postgraduate levels, special education, and professional development.
Description of AI tools application	Studies that clearly explain what and how AI tools were applied in self-directed ESL/EFL.	Studies without a clear description of what and how AI tools were applied in self-directed ESL/EFL.

AI tools application outcomes	Studies that clearly reported the outcomes of the application of AI tools in self-directed ESL/EFL.	Studies that do not report the outcomes of the application of AI tools in self-directed ESL/EFL.

(Source: The authors)

4.2 Data extraction

The initial phase involved extracting foundational information, including authorship, research topics, year of publication, geographic location, domain (ESL/EFL), study context, methodological framework, data collection strategies, and participants. To explore emerging patterns and the integration of AI in ESL/EFL contexts, the data extraction extended to include key elements such as the specific language competencies these tools aimed to enhance, the types of AI tools deployed, and the supporting evidence of their impact on fostering learners' self-directed learning. Following this, the study evaluated how effectively AI tools contributed to ESL/EFL instruction. This assessment employed a classification approach, categorising outcomes into five distinct labels: totally positive, totally negative, more positive than negative, more negative than positive, and could be positive or negative. This categorisation yielded valuable insights into both the opportunities and challenges posed by various AI tools. Ultimately, it informed a nuanced understanding of how AI tools can support self-directed ESL/EFL learning at the tertiary level.

4.2 Data trustworthiness

The Gorard Trust mechanism (2014) was employed as a framework for assessing the trustworthiness of the selected publications. This approach evaluates studies based on key factors, including the coherence of research scope, research design, sample representativeness, data quality, fidelity of intervention, and potential threats to validity. During the screening process, only studies with robust methodologies and transparent reporting are included, minimising bias and enhancing the credibility of findings.

5.0 Results and discussion

5.1 Research trend of the use of AI tools

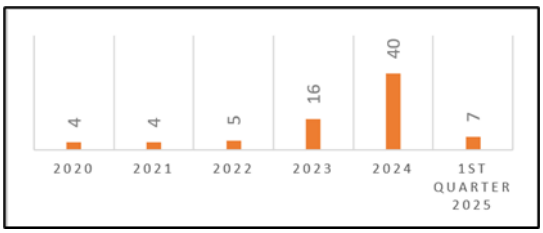

Fig. 3: Temporal distribution of publications
(Source: Research findings)

Fig.3 captures the progression of research exploring AI-driven support for self-directed ESL/EFL in higher education. From 2020 to 2022, output remained modest and consistent, averaging 4 studies annually. A sharp increase was observed in 2023 (n = 16), followed by a substantial rise in 2024 (n = 40). Through the lens of Activity Theory, learners (subjects) approach ESL/EFL objectives (objects) driven by personal aspirations such as enhancing their learning competence and refining their individual study behaviours, while AI technologies (tools) mediate and transform this interplay. Aligned with Nguyen and Le's (2025) perspective, the continuous interactions among subjects, tools, and objects generate rich data streams and performance metrics that researchers analyse to refine AI models, publish empirical studies, and propose best-practice frameworks. Each empirical insight feeds back into tool design, spurring iterative innovations and explaining the sharp uptick in AI-driven ESL/EFL research since 2023.

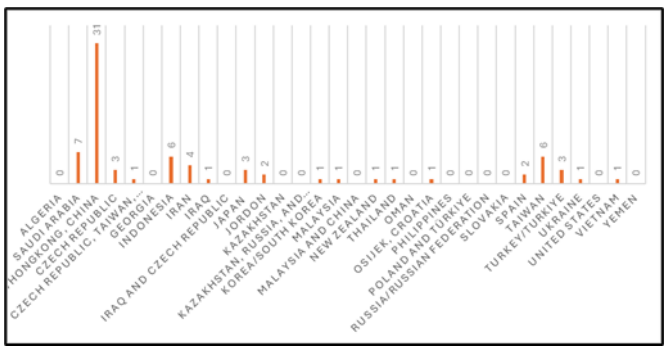

Fig. 4: Chronology distribution of publications
(Source: Research findings)

While 2025 data is currently limited to the first quarter, 7 relevant studies have already been documented. To further examine emerging patterns, a targeted search was conducted for the second quarter (March–July 2025), revealing an additional 5 records from Scopus, 169 from WoS, and 306 from Education Research Complete@EBSCOhost, pending for further screening. Nonetheless, this follow-up search suggests that 2025 may match or exceed 2024 in research volume, which signals a marked intensification of academic interest in AI applications within the ESL/EFL landscape in higher education.

Consistent with the findings of Nguyen and Le's (2025) recent technology-focused language education review, Fig.4 highlights China as the dominant contributor to research on AI-supported self-directed ESL/EFL, with 31 studies, reflecting a strategic emphasis on integrating AI in language education. This leadership stands in stark contrast to the notably lower outputs from other countries, such as Saudi Arabia follows with 7 publications, while Indonesia and Taiwan each produced 6, and Iran 4. Countries such as the Czech Republic, Japan, and Turkey/Türkiye each registered 3 studies. A significant number of countries either lacked representation or had a minimal presence in this research domain, suggesting uneven global engagement with AI-enhanced ESL/EFL practices.

This dimension aligns with the "rules" component of Activity Theory, which influences how relationships between subject, object, and tool are shaped and perceived. In this context, the "rules" refer to educational norms governing the integration of AI tools for self-directed ESL/EFL learning within specific educational environments. The notable disparity in AI adoption between China and other nations may be linked to differing educational norms across country contexts, exemplified by China's launch of the "New Generation Artificial Intelligence Development Plan" and substantial state investments aimed at establishing AI as a cornerstone of industrial transformation (Roberts et al., 2020). These strategic initiatives go beyond the efforts observed in many other countries. Although the current study does not delve deeply into these factors, they point to a meaningful avenue for future investigation.

In examining disciplinary focus, the majority of studies (90%) concentrated on EFL, with a smaller subset addressing ESL and ESP (ESP was included for its relevance to the broader ESL/EFL framework). However, the reliability of this classification may be compromised due to inconsistent usage of terminology across studies. In some cases, research originating from the same country applied ESL and EFL interchangeably, reflecting contextual ambiguity. For example, countries formerly colonised by the United Kingdom or the United States, such as India, Malaysia, Nigeria, and Philippines, typically categorise English as a second language (ESL). In contrast, countries like Turkey, Japan, Indonesia, and China generally treat English as a foreign language (EFL). Interestingly, discrepancies appear even within specific country datasets: studies from Spain with the same group of researchers alternately used EFL (Tejedor-García et al., 2020a) and ESL (Tejedor-García et al., 2020b), and Japanese studies showed similar inconsistency, such as Dizon (2020) used EFL, Dizon and Tang (2020) used ESL. These variations suggest that historical ties and educational policies may influence terminological choices, though not always systematically. Further investigation is warranted to clarify and standardise disciplinary distinctions across national contexts.

5.2 The trending AI tools

AI-powered chatbots, including ChatGPT, Microsoft Copilot, Gemini, Bing AI/Bing Copilot, Perplexity, and Replika, emerged as the most frequently used. Across the spectrum of AI-powered chatbots reviewed in this study, ChatGPT attracted the greatest focus, consistent with Amoah et al.'s (2025) report indicating that over 70% of students globally employ it. Nonetheless, its instructional functions mirror those of other chatbot tools within self-directed ESL/EFL learning environments, as consistently observed in multiple studies. In this regard, the division of labour within self-directed ESL/EFL learning environments significantly influences the adoption and visibility of AI tools by shaping how different users engage with them. For instance, by regularly using AI-powered chatbots, learners improve self-direction through goal setting, planning, and feedback adaptation. Their critical use of AI services sharpens language skills and helps increase the visibility of these tools in ESL/EFL (Zhou et al., 2025). Moreover, administrators' support for essential trainings (Aladini et al., 2025), teacher-led moderation and licensing of effective chatbots (Savchenko et al., 2023) ensures structured, responsible, and widespread use of AI tools across learning environments.

Trailing behind are AI-powered language learning platforms such as Duolingo, AI-IDLE, Cambly, UNIPUS AIGC, and WEXT. Duolingo stood out as the most popular, credited for consolidating various useful features into a single, user-friendly interface. As part of its evolving capabilities, it periodically incorporates chatbots like ChatGPT to foster deeper topic exploration, along with AI-enabled translation tools like Google Translate to assist with practice tasks and assignments (Pikhart et al., 2024). To that note, many instructors are now actively adopting diverse AI tools and integrating them into well-structured classroom settings that align with learning goals. Pikhart et al. (2024) confirmed that the structured multi-bot ecosystems support varied learners' proficiency and preferences, which directly fuel the growing trend and high-frequency use of AI technologies in ESL/EFL environments.

In third position are applications that harness Automatic Speech Recognition (ASR) technologies like Google Text-to-Speech, VoiceMaker, Elsa Speak, and iFlyRec, alongside Automated Writing Evaluation (AWE) tools such as Quillbot, Grammarly, Pigai, and Criterion. AI-enabled translation services, including Google Translate and DeepL Translator, occupy the fourth spot. Fifth in prevalence are AI speaking applications focused on enhancing spoken communication. Although other AI tools appear less frequently, they nonetheless demonstrate encouraging potential in supporting self-directed ESL/EFL. This upward trend in AI tools adoption can be attributed, in part, to the efforts of AI platform designers. AI platform designers contribute significantly to the rising popularity of AI tools by continuously enhancing usability and performance. Key improvements include more accurate feedback (Liu et al., 2022), increased responsiveness to cultural and emotional nuances (Aladini et al., 2025), and faster system compatibility for efficient integration with educational platforms (Zhao & Liu, 2022).

5.3 Effectiveness of AI tools in supporting self-directed ESL/EFL

Through the lens of Activity Theory, the results in Fig.5 align with the concept of "outcomes", representing a dynamic result shaped by the interplay of system elements such as subject, object, tools, community, rules, and division of labour (Engeström, 1987). These components collectively mediate the user's experience and interpretation, highlighting that perceived effectiveness is not inherent to the technology alone but emerges from its contextual application.

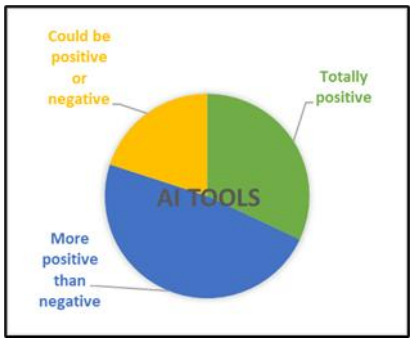

Fig. 5: The effectiveness of AI tools
(Source: Research findings)

Finding reveals that none of the reviewed publications assessed effectiveness reports as "more negative than positive" or "totally negative," indicating that AI-based approaches were consistently perceived in a neutral or positive light. Several outcomes classified under the "could be positive or negative" category suggest a potentially variable shift in perceived effectiveness, which merits further exploration. The findings align with recent AI reviews on effectiveness in ESL/EFL, showing high positive outcomes (Jeon, 2025). Subsequently, this study highlights several notable limitations of current AI tools in supporting self-directed ESL/EFL, underscoring areas that warrant attention from instructors, instructional designers, and AI platform developers when integrating such tools into pedagogical practices. Alongside these insights, the study proposed targeted strategies to mitigate identified challenges, bridge existing gaps, and optimise the pedagogical efficacy of AI tools in self-directed ESL/EFL education (see Table 2). Importantly, the implications of this study may guide instructors in selecting and implementing appropriate AI tools, while also helping learners to recognise existing limitations and adopt strategies to overcome them.

Table 2. Current limitations of AI tools and the suggestions to overcome

AI tools' limitations	Suggestions to overcome
Emotional and Cultural Insensitivity Chatbot - responses often lacked emotional warmth, contextual relevance, and cultural nuance	Integrate tools that facilitate learner-created content, collaborative reflection, and meaningful dialogue, helping to deepen emotional connection and enhance cultural awareness in language learning contexts.
Information Accuracy Issues Chatbot - the feedback was occasionally inaccurate or misleading ASR - misrecognised lexical category and less common words	Integrate supplementary tools that provide structured, multimodal lexical support and contextualised examples. Such tools should facilitate human validation through instructor feedback and collaborative reflection, fostering richer emotional engagement and cultural relevance in the learning process.
Insufficient Guidance and Validation Mechanisms ASR - transcribed learner inputs despite incorrect pronunciation, leading to inaccurate outputs/ limited verification processes contributed to unreliable learning support.	Incorporate tools that offer phonetic support and facilitate deeper engagement with pronunciation practice across diverse accents and natural language use.
Cognitive Load Concerns AI-powered language learning platform - cognitive strain for mid-level learners, e.g., information overload ASR – feedback was difficult for learners to interpret effectively AWE - systems overwhelmed learners with advisory messages, learners favor direct instructions to correct errors	Incorporate tools that visually highlight errors and provide straightforward verbal explanations. Besides, streamlined instruction helps learners focus on actionable corrections rather than navigating excessive information.
Fragmented Learning Processes Chatbot - risk promoting unsystematic and disjointed learning experiences	Integrating structured learning environments with tools that facilitate sequential instruction and reflective engagement helps scaffold content delivery and guide task progression in alignment with pedagogical goals.

Note. This study only focuses on the trending AI tools identified in this present paper.
(Source: Research findings)

6.0 Limitation and recommendations for future studies

This review is subject to several limitations stemming from its inclusion and exclusion criteria. By restricting the scope to peer-reviewed journal articles published in English between 2020 and the first quarter of 2025, potentially valuable insights from earlier studies, grey literature, non-English publications, and alternative formats such as conference proceedings or dissertations were excluded. To address these limitations, future research could adopt a broader scope of sources to capture a wider range of insights and innovations. Additionally, the focus on higher education and self-directed ESL/EFL learning may have overlooked relevant findings from adjacent educational levels or broader language learning contexts. Expanding the focus beyond higher education to include other educational levels and contexts may also reveal transferable strategies and challenges in AI-supported self-directed ESL/EFL.

7.0 Conclusion

Grounded in Activity Theory, this review explores the evolving landscape of AI-supported self-directed ESL/EFL in higher education by mapping key research trends, identifying prominent AI tools, and evaluating their pedagogical impact. Since 2023, exponential growth in related research reflects intensifying academic interest, driven by ongoing improvements in AI tools and increasing recognition of their value in fostering self-directed learning. However, uneven global distribution highlights disparities in AI adoption and calls for more balanced international research efforts, as well as clearer disciplinary terminology to ensure inclusive and consistent application. Among the diverse AI tools examined, chatbots emerge as the most dominant, with their prevalence expected to grow alongside a structured division of labour within educational ecosystems. Notably, most AI tools used in self-directed ESL/EFL contexts are perceived as either effective or neutral in their impact.

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Paper Contribution to Related Field of Study

Beyond identifying trending tools, this study critically investigates their limitations and synthesises pedagogically grounded recommendations to help navigate these challenges. It supports pedagogical innovation by offering actionable guidance that enables instructors to make informed choices, mitigate potential drawbacks, integrate technologies effectively, and align AI-enhanced practices with instructional goals and learner needs. Its relevance extends beyond ESL/EFL, offering insights applicable to other areas of language education.

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