

Systematic Review on The Role of AI Self-Directed Learning in Enhancing Arabic Language Skill Acquisition

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ABSTRACT

This conceptual paper reviews the role of AI-powered self-directed learning (SDL) tools, with a focus on adaptive learning platforms, in Arabic skill acquisition. Despite widespread adoption of AI in language learning, there is a persistent gap in rigorous and up-to-date syntheses on how AI-enabled SDL supports Arabic learning processes within diverse linguistics features and translate these insights into a coherent framework that guides design, implementation and evaluation in real-world contexts. Studying on a broad spectrum of theoretical perspectives, this paper is intended to synthesize how organised practices and adaptive learning platforms can scaffold learners' comprehension in all language aspects. It presents a structured synthesis of concepts, identify recurrent gaps in theory and evidence, and propose a multi-layer framework that positions AI-driven features, learner factors and instructional design within an input-process-outcome model. By utilising qualitative research methodology, this systematic review examines the most relevant 37 research articles to the role of artificial intelligence (AI)-based self-directed learning applications in the acquisition of Arabic language skills in the contemporary educational context. Implications are offered for researchers, educators, and developers aiming to design culturally and linguistically relevant AI language skill tools for Arabic. This analysis found, despite these achievements, there are challenges that need to be addressed for some complex tasks due to language's deep

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cultural context and variation of dialects and expressions
The paper also outlines a rigorous agenda for future research, including methodological approaches to validate the framework across dialects, scripts, and learner contexts.

1. Introduction

In an increasingly interconnected world, the demand for Arabic language competence among non-native speakers has grown substantially, propelled by several prominent factors particularly globalisation, cultural exchange, and workforce needs (Rachel Gugu & Oluwatoyin, 2024; Muhammad Miftah et al., 2026). International language acquisition frameworks such as the Common European Framework of Reference for Languages (CEFR) and aligned digital literacy standards, emphasise not only on linguistic proficiency but also autonomous and lifelong learning skills. Recent analyses show that AI-powered self-directed learning (SDL) tools as crucial in enabling learners to pursue personalised language skill practice, monitor progress, and regulate study routines outside traditional classroom boundaries. However, systematic evidence on how AI-enabled SDL specifically shapes Arabic skills development remains fragmented, with outcomes normally depend on platform design, learners' level of motivation and contextual diversity (Khader Rajabi, 2025; Yazid Hady, 2026).

In Malaysia particularly, the educational landscape has prioritised multilingual proficiency and digital readiness, with the Malaysia Higher Education Blueprint 2015-2025 emphasising on higher-order language skills, including listening, reading, writing and speaking; across implemented curricula and assessments. Apart from that, Arabic language education in Malaysia faces extra challenges where the language characteristics such as dialect variation, script complexity, and grammar system are far different than Malaysian native language (Maher Itani, 2017; Farouk et al., 2024). Recent policy-relevant reviews highlight the importance and potential of Self-Directed Learning (SDL) to emphasise on multilingualism and language quality (Katia Carraro, 2023), while stressing the need for culturally and linguistically responsive AI design that respects Modern Standard Arabic and dialectal diversity within Malaysian classrooms (Khazri Osman et al., 2025).

This study targets university education as a critical juncture for shaping independent learning habits and foundational literacy in Arabic. By synthesising contemporary AI-literacy research and aligning them with theoretical lenses on SDL/SRL, sociocultural mediation, and cognitive load, this paper proposes a framework that clarifies how adaptive learning platforms can scaffold language skills development, while accounting for learner autonomy, motivation, digital fluency, and dialect exposure. The aim is to offer actionable guidance for researchers and practitioners seeking evidence-based, scalable AI-supported learning interventions at university level, with implications for broader higher education contexts.

2. Research Problem

The rapid fragmentation of AI-driven educational technologies has transformed language learning (Luis Cabral et al., 2025), yet Arabic language education seemed parallel to learning of other languages in adapting AI-powered self-directed learning (SDL) specifically in language skills acquisition in higher education settings (Yazid Hady

et al., 2026). Despite widespread adoption of adaptive learning platforms and intelligent tutoring systems (Gao, 2023), there is a persistent gap in rigorous and up-to-date syntheses that, first, articulate how AI-enabled SDL supports Arabic learning processes within diverse linguistics features (Mohammed Muzaal & Tahseen Ali, 2020), and second, translate these insights into a coherent framework that guides design, implementation, and evaluation in real-world Malaysian and global contexts (Khazri Osman et al., 2025). Recent reviews reveal benefits and challenges for AI-assisted language learning, with focus on personalised learning pathway, improved pedagogy and assessment, enhanced feedback mechanism and reduced administrative workload. While the persistent challenges involve infrastructure limitations, inadequate teacher training algorithmic bias, ethical and data-privacy concern and inequities in access (Mohammed Muzaal & Tahseen Ali, 2020; John Adil, 2025; Khazri Osman et al., 2025).

Based on this gap, the present study advances a conceptual literature review together with a proposed framework for AI-powered adaptive learning platforms tailored to Arabic language skills acquisition. By synthesizing theoretical perspectives on self-directed or self-regulated learning, sociocultural mediation, cognitive load, and multimedia learning, this work aims to identify core mechanisms by which AI-enabled SDL can enhance language skill proficiency, and to specify the role of SDL in language learning for university level. The contribution can be derived from both theoretical and practical aspects by informing the design of culturally and linguistically responsive adaptive learning tools that align with contemporary language education goals for example, those outlined by major international language learning frameworks and regional education policies.

3. Literature Review

AI has become a pervasive driver of personalised learning that characterised with data-driven decision-making, automated feedback, and adaptive pacing that align with individual learner characteristics (John Adil, 2025). In education generally, AI-driven systems have demonstrated a potential to improve engagement with learners and more importantly could reduce cognitive load among them and support metacognitive strategies when thoughtfully designed (Rachel Gugu & Oluwatoyin, 2024). For Arabic language education particularly, AI applications must also be able to navigate script complexities such as, diacritics issues which does not exist in other languages, diglossia, and cross-dialect intelligibility, which amplifies the importance of culturally and linguistically aware design (El-Hady & Ahmed, 2020; Farouk et al., 2024, Nanin et al., 2026).

In language education, these capabilities in AI application will benefit language skills learning, where vocabulary, syntax, and comprehension must be coordinated in real time (Alhusaiyan, 2025). AI-powered self-learning tools that may range from intelligent tutoring systems and adaptive drills to language-rich chatbots (Alhusaiyan, 2025) and reading analytics dashboards (Luis Cabral et al., 2025); offer specific diagnostics of reader profiles in adjusting text difficulty in accordance with these profiles, scaffolding strategies, and feedback to match current competencies of users (Gao, 2023, Mahendra & Anil, 2026). This learning tool can enhance learning engagement by presenting appropriately challenging texts, providing live feedback, and fostering self-regulated practice patterns that extend learning beyond the classroom (Kazi Bushra et al., 2026). Experts also assure efficiency gains for educators and scalable access to high-quality learning material experiences by learners, particularly in contexts with limited specialist

instruction or diverse learner populations (Gao, 2023; Rachel Gugu & Oluwatoyin, 2024).

Nevertheless, the AI-enabled learning tool for Arabic language learning is still not fully effective (Al-Shaboul et al., 2025). Al-Afnan (2021) elaborated that the complexity of the Arabic language characterised by its rich morphology, diglossia, and dialectal variations present significant challenges for learners, translator and natural language processing (NLP). These challenges have historically hindered the development of effective language learning tool (Al-Shaboul, 2025). Although a lot of improvements in accuracy and fluency of AI tools had been achieved in overcoming these challenges, some complex tasks remain unsolved due to language's deep cultural context and the prevalence of dialectal variations (Al-Shaboul et al., 2025) that may cause algorithm bias especially in determining students' language proficiency in self-directed learning. Transparency of algorithms and the ability of learners to interpret AI recommendations will impact trust, effort, and their motivation towards language learning (Abouelnour et al., 2026). Digital literacy also emerges as a moderator; a study carried out by Phan & Nguyen (2026) revealed that the ability to use AI does not equal among students, learners who are comfortable with digital tools are more likely to leverage adaptive features, interpret analytics, and able to sustain with self-directed practice, whereas those with limited digital fluency may struggle to pick up actionable insights from AI feedback (Nur Maslina et al., 2024). These findings underscore a critical design implication that AI language learning tools must not only personalise content but also cultivate learners' metacognitive skills, strategic approaches to text processing, and digital literacies from learners to interpret and act on AI-driven guidance.

4. Research Methods

A systematic literature review (SLR) was employed as the research methodology to qualitatively examine the role of artificial intelligence (AI)-based self-directed learning applications in the acquisition of Arabic language skills in the contemporary educational context. According to Vuori and Väisänen (2009), conducting a systematic literature review is essential because "it is a valuable strategy when the aim is to identify, evaluate, and synthesise all of the important research on a certain topic to acquire a complete picture of the studies and their findings." This systematic review adopted the five general steps proposed by Khalid et al. (2003), as outlined below (Figure 1).

The five stages outlined below were implemented to ensure that the selected literature was rigorously screened, verified, and analysed for its relevance to the objectives and thematic focus of this study. Examining a substantial body of literature enables researchers to identify the principal areas of scholarly attention within a particular field, reveal existing research gaps, and highlight unresolved issues that warrant further investigation.

Table 1 presents the online databases that served as the primary sources of literature for this systematic review. These databases were accessed through the institutional subscription provided by Universiti Sains Islam Malaysia (USIM), as most of them require paid subscriptions. To retrieve relevant studies, the researchers employed a set of predefined search keywords, including *"artificial intelligence in education," "self-directed learning,"* and *"artificial intelligence in Arabic language skills learning."* As a result, 116 articles were considered related to the topic from each keyword. However,

when those three (3) keywords were combined, 37 articles appeared to be the most relevant to the topic and aims of the research.

Figure 1: 5 adopted steps in systematic review analysis

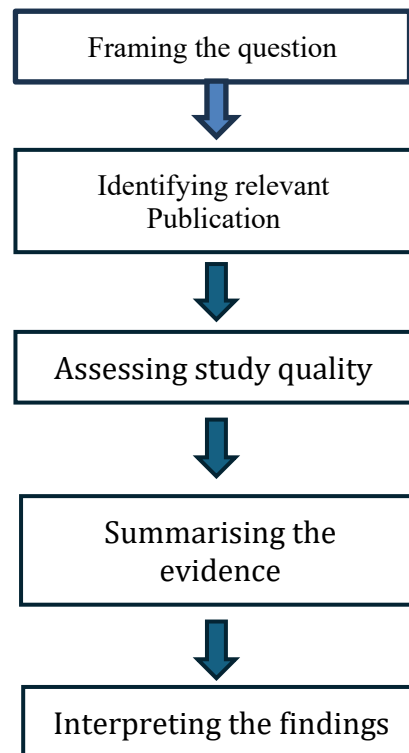


Table 1: Search online database for all relevant studies

No	Journal
1	Springer Nature
2	Scopus
3	ProQuest
4	AskZad
5	JSTOR
6	Google Scholar

4.1 AI-powered tools for language learning

Artificial Intelligence (AI) has transformed language education by providing adaptive, interactive, and personalized learning experiences. AI-powered tools support the development of the four core language skills, through intelligent algorithms, natural language processing (NLP), speech recognition, machine learning, and generative AI (Logic Magwa, 2026). Rather than replacing teachers, these tools function as intelligent learning assistants that provide immediate feedback, personalized instruction, and opportunities for autonomous learning (Hu, 2024; Yazid Hady et al., 2026). Among these tools are:

4.1.1 Intelligent Tutoring Systems (ITS)

These systems simulate one-to-one tutoring by diagnosing learners' strengths and weaknesses and adapting instructional content accordingly. ITS collect data from

learners to form individualised profiles and models tailoring content to each learner's need and progress (Alhusaiyan, 2024). They adapt item difficulty, sequencing, and feedback in real time (Malekzadeh et al., 2015). Over time, the ITS system is not only modelled by learner knowledge, but other characteristics such as learning style, activities and affect states contribute to form system personalised respond (Gao, 2023). Such systems have demonstrated effectiveness in improving learner engagement and achievement because they adjust the level of difficulty according to learners' performance (Ma et al., 2014). In language learning, ITS can provide grammar explanations, vocabulary practice, and comprehension exercises tailored to individual needs.

4.1.2 Natural Language Processing (NLP)-based tools

These tools enable computers to understand, process, and generate human language (Hu, 2024). In language education, NLP supports grammar checking, vocabulary enhancement, automated text summarisation, machine translation, sentiment analysis, and text simplification (Khazri Osman et al., 2025). Applications employing NLP allow learners to receive immediate corrective feedback on grammatical errors, lexical choices, and sentence structures, thereby promoting self-directed learning (Yazid Hady et al., 2025). According to Jurafsky and Martin (2025), NLP technologies form the foundation of many contemporary language learning applications by enabling meaningful interaction between learners and computer systems.

4.1.3 Automatic Speech Recognition (ASR) tools

They represent another significant advancement, particularly for speaking and pronunciation practice. ASR converts spoken language into text and evaluates pronunciation accuracy, fluency, and speech clarity (Zubair, 2026). Learners can repeatedly practice speaking while receiving immediate feedback without requiring a human instructor (Al-Shaboul et al., 2025). Research indicates that ASR technology contributes positively to pronunciation development, speaking confidence, and oral fluency, especially in second-language learning environments (McCrocklin, 2019). Modern language-learning applications increasingly integrate ASR to facilitate autonomous speaking practice.

4.1.4 Generative AI (GenAI)

This tool further expanded opportunities for language learning. GenAI can generate human-like text, simulate authentic conversations, answer learners' questions, explain grammar, create writing prompts, and provide personalized feedback on written assignments (Al-Kaabi & Al-Maamari, 2025). These capabilities enable learners to engage in contextualized language practice that resembles interaction with a human tutor (Khazri Osman et al., 2025). Furthermore, generative AI supports task-based learning by producing dialogues, role-play scenarios, summaries, and customized language learning materials appropriate to learners' proficiency levels (Kasneci et al., 2023). However, educators should encourage critical evaluation of AI-generated content because occasional factual or linguistic inaccuracies may occur.

4.1.5 AI-powered conversational agents and chatbots

They facilitate interactive language practice through real-time dialogue. These systems simulate authentic communication by responding to learners' inputs in natural language (Watcharapol Wiboolyasarin et al., 2025). Natural language understanding (NLU) and generation (NLG) enable adaptive dialogue that challenges learners with higher-order questions as their proficiency level grows (Mahendra & Anil, 2026). Chatbots promote communicative competence by providing opportunities to practice conversation in low-anxiety environments where student can progress themselves at their own pace (Watcharapol Wiboolyasarin et al., 2025; Kazi Bushro et al., 2026). They are particularly valuable for developing speaking and writing skills, increasing learner motivation, and supporting self-paced learning (Fryer & Carpenter, 2006). Recent conversational AI systems integrate NLP, ASR, and generative AI to create increasingly realistic language-learning experiences. Among these chatbots that are available are talkpal, Copycat Café, learna AI and many more.

4.1.6 Content-generation and Retrieval-Augmented Tools

These tools operate by pulling data from established corpora to assemble authentic or pedagogically designed texts at a chosen level of difficulty (Vivian Wu et al., 2025). They embed guided questions, activities, and linguistic notes, then adjust discourse complexity based on the learner's performance (Khazri Osman et al., 2025). AI can also simulate authentic language tasks in various genre of materials with embedded comprehension checks and reflection prompts, supporting transfer of language skill strategies to real-world materials (Al-Kaabi & Al-Maamari, 2025). For example, AI systems that adapt or generate reading passages and questions on demand, using retrieval-augmented generation to tailor texts to learner interests and cultural context.

Overall, these AI-powered self-learning tools share core mechanisms in terms of data-driven personalisation, real-time adaptive feedback and support for metacognitive strategy use. They rely on robust AI components and machine learning models to infer knowledge states, NLP for language processing, and data visualisation for actionable insights.

5. Results

Arabic language skills acquisition is a comprehensive effort that hinges on various language aspects in terms of phonological accuracy, morphological awareness, vocabulary depth, grammatical understanding, and reading comprehension, all of which depended on continuous practices by learners. AI-powered self-learning tools; especially adaptive learning platforms and intelligent tutoring systems, offer a principled approach to demonstrate these interdependent components within learner-centred and self-learning strategy. These artificial intelligence tools promise a transformative shift in the evolution of knowledge. Despite these achievements, there are challenges that need to be addressed for some complex tasks due to language's deep cultural context and variation of dialects and expressions (Nanin et al., 2026). Arabic presents script complexities that are difference from Malays, such as diacritics and ligatures; morphology and grammar system (Nanin et al., 2026); in addition to varieties of dialect due to geographical factor that could affect text understanding. Therefore, culturally and linguistically aware design is essential in the development of the tool. The developer must ensure the system supports both Modern Standard Arabic and dialectal exposure

while respecting orthographic conventions, which may vary by region and educational level (Maher Itani, 2017; Al-Khafaji, 2025).

Many studies highlighted the necessity of domain-sensitive feedback in the development of SDL design that accounts for root-pattern morphology, contextual cues, and discourse-level coherence, as well as datasets representative of diverse Arabic varieties to avoid bias and ensure equitable learning outcomes (El-Hady & Ahmed, 2020; Farouk et al., 2024; Mohammed, 2021). A good AI-powered SDL application when designed with linguistic humility and transparency, it can analyse learner inputs, identify linguistic patterns, and adjust content to meet individual learning need (M. Li & Hegelheimer, 2013). However, the absent of robust linguistic grounding or systems that misrepresenting morphological relationships or misaligning with Arabic's dialects, thereby hindering transfer to authentic language skills tasks (Mohammed Muzaal & Tahseen Ali, 2020).

A critical design of an AI tool is the centrality of a feedback quality and interpretability. AI-driven feedback should do more than signal correctness; it should illuminate conversational environment, improve grammatical skills (Abouelnour et al., 2026), provide immediate comment for students to adjust their learning strategies and help them track their progress (Kazi Bushra et al., 2026). This includes explicit scaffolds for revealing strategies, semantic processing such as contextual guessing and inference, and metacognitive regulation in term of goal setting, monitoring and reflection. When feedback is aligned with SRL cycles and presented through culturally embedded interfaces; learners are more likely to internalise effective language skill strategies and maintain autonomous practice. Studies in AI-assisted language learning consistently indicate that teacher and learner trust in the system that reinforced by transparent data use, understandable feedback, and visible learning progress will predicts sustained engagement and better outcomes (Uygun & Demir, 2026).

In Arabic language particularly, AI-powered approaches have been investigated for all four language skills; reading, writing, listening, and speaking, with particular emphasis on pronunciation feedback, morphological analysis, and error detection (Al-Kaabi & Al-Mamaari, 2025). Meanwhile, the availability of adaptive platforms promises targeted practice aligned to learner profiles (Gao, 2023), yet evidence indicates variable efficacy across complex nature of Arabic grammar and diverse regional diglossia (Al-Kaabi & Al-Mamaari, 2025). Recent reviews emphasize the necessity of robust datasets, culturally embedded feedback, and transparent AI behaviour to sustain learner motivation and trust, especially when learners are navigating Modern Standard Arabic alongside dialects (Al-Khoury & Sallam, 2021; Hussein & Omar, 2022).

Syntheses focus on the insight that AI-powered SDL tools with adaptive learning support can improve learners' fluency and comprehension especially when combined with deliberate practice, diverse resources, and effective reflection (Phan & Nguyen, 2026). In higher education contexts, studies reveal that learner autonomy and timely feedback mediate gains in lexical development and comprehension, while platform transparency and alignment with curricula shape engagement and continuous use. Arabic language skill acquisition includes morphology, vocabulary, grammar, and comprehension (Khazri Osman et al., 2025), all of which are influenced by script familiarity (Abubakar Garba & Abd Rauf, 2024), diglossia, and exposure to authentic texts (Abouelnour et al., 2026). All studies reviewed indicate that language proficiency emerges from repetitive cycles of continuous practice and semantic processing with AI-enabled SDL tools

offering adaptive scaffolding that targets individual language weaknesses. Nonetheless, the literature cautions that improvements depend on the alignment of feedback modalities with learners' metacognitive strategies and the linguistic features of Arabic.

6. Conclusion

This paper has articulated a theoretically grounded and practically oriented examination of AI-powered self-learning tools and their potential to advance Arabic language skill acquisition within pre-university and higher-education contexts. By foregrounding an integrative lens that draws on self-directed learning besides cognitive-load considerations, the discussion advances a coherent understanding of how adaptive learning platforms can scaffold learners' comprehension in all language aspects. The central discussion is that the value of AI-enabled SDL for language skill emerges not from algorithmic sophistication alone, but from the alignment of adaptive feedback, task design, and metacognitive supports with learners' knowledge and socio-linguistic realities. Effectiveness much depends on transparent feedback loops, culturally and linguistically organised content, and designs that privilege learner autonomy without sacrificing instructional coherence.

The proposed conceptual framework offers a diagnostic and prescriptive map for researchers and AI-driven tool developers for language learning. It demonstrates how AI features interact with learner factors and contextual moderators to produce measurable gains in language skills learning outcomes and self-regulation. The synthesis cautions that gains are sensitive to specific domain variables, including Arabic diglossia, script complexity and dialect exposure, underscoring the need for contextually rich datasets, rigorous validation across settings, and transparent reporting of AI abilities. Moreover, equity factors such as accessibility to devices, digital literacy, and culturally relevant content, emerge as critical determinants of differential impacts that demand inclusive design practices and policy attention.

Looking forward, the study advocates a multi-method research agenda that combines longitudinal designs, cross-context replication, and design-based implementations to test propositions and refine the framework. By integrating extensive methodologies with pragmatic design guidance, AI-powered SDL tools can substantially contribute to sustainable improvements in Arabic language proficiency and support tangible development among learners in diverse educational landscapes.

Ethics Approval and Consent to Participate

Not applicable.

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Conflict of Interest

We would like to declare that there are no conflicts of interest associated with this publication. All authors have been fully informed and actively participated in the study.

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