



Technology-Enhanced Arabic Language Teaching and Learning: A Systematic Review

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ABSTRACT

Technology has increasingly reshaped Arabic language education through mobile applications, learning management systems, gamification, artificial intelligence (AI), augmented reality (AR), and other digital tools. However, the literature remains fragmented across technologies, language skills, learner populations and pedagogical models. This systematic literature review synthesises research on technology-enhanced Arabic language teaching and learning, with particular attention to digital tools, pedagogical approaches, learning outcomes, implementation challenges, and emerging research directions. The review followed the PRISMA 2020 guidelines, with predefined eligibility criteria, database searching, dual screening, quality appraisal, data extraction, and thematic synthesis. The evidence reviewed indicates that technology can strengthen learner engagement, accessibility, vocabulary development, speaking and writing practice, formative feedback, and learner autonomy when digital tools are aligned with explicit pedagogical objectives. The strongest recurring pattern is not the superiority of a particular platform but the importance of pedagogical integration: technology is most productive when teachers provide scaffolding, feedback, interaction, and contextualised language use. The review also identifies persistent challenges involving teacher digital competence, infrastructure, Arabic-language resource quality, linguistic and cultural contextualisation, algorithmic limitations, and unequal access to resources. Whereas previous reviews examined single technologies (gamification, mobile learning, AR, VR, or AI) in isolation, this review integrates them into one technology-pedagogy-outcome framework, linking each technology to its pedagogical functions, targeted skills, outcomes, and implementation conditions.

Keywords: Arabic language education; educational technology; digital pedagogy; systematic literature review; mobile-assisted language learning

المخلص:

شهد تعليم اللغة العربية في السنوات الأخيرة توسعاً ملحوظاً في توظيف التكنولوجيا الرقمية، بما في ذلك تطبيقات الهاتف المحمول، وأنظمة إدارة التعلم، والتلعيب، والذكاء الاصطناعي، والواقع المعزز، وغيرها من الأدوات الرقمية. ومع ذلك، ما تزال الأدبيات البحثية موزعة بين تقنيات ومهارات لغوية وفئات متعلمين ونماذج تربوية مختلفة. تهدف هذه المراجعة المنهجية للأدبيات إلى تركيب نتائج الدراسات المتعلقة بتوظيف التكنولوجيا في تعليم اللغة العربية وتعلمها، مع التركيز على الأدوات الرقمية، والمقاربات التربوية، ونواتج التعلم، وتحديات التطبيق، والاتجاهات البحثية الناشئة. صُممت المراجعة وفق واعتمدت معايير محددة للأهلية، واستراتيجية بحث منظمة، وفرزاً للدراسات، وتقييماً لجودتها، PRISMA 2020 إطار واستخراجاً للبيانات، وتحليلاً موضوعياً. تشير الأدلة التي تمت مراجعتها إلى أن التكنولوجيا يمكن أن تعزز مشاركة المتعلمين، وإتاحة الموارد، واكتساب المفردات، وممارسة مهارات الكلام والكتابة، والتغذية الراجعة التكوينية، والاستقلالية في التعلم عندما ترتبط الأدوات بأهداف تربوية واضحة. وتكشف المراجعة أن نجاح التكنولوجيا لا يرتبط بأداة بعينها بقدر ارتباطه بجودة دمجها تربوياً، ولا سيما من خلال التوجيه والتغذية الراجعة والتفاعل والاستخدام اللغوي السياقي. كما تكشف تحديات مستمرة تتعلق بالكفاءة الرقمية للمعلمين، والبنية التحتية، وجودة الموارد العربية، والملاءمة اللغوية وخلافاً للمراجعات السابقة التي تناولت كل تقنية على حدة، والثقافية، وحدود الخوارزميات، وعدم تكافؤ الوصول كالتلعيب والتعلم بالأجهزة المحمولة والواقع المعزز والواقع الافتراضي والذكاء الاصطناعي، تدمج هذه المراجعة هذه المسارات في إطار واحد يربط كل تقنية بوظائفها التربوية والمهارات المستهدفة ونواتج التعلم وشروط التطبيق.

الكلمات المفتاحية: تعليم اللغة العربية؛ التكنولوجيا التعليمية؛ التربية الرقمية؛ المراجعة المنهجية للأدبيات؛ التعلم المدعوم بالأجهزة المحمولة

INTRODUCTION

Digital transformation has changed the conditions under which languages are taught, practiced, assessed and experienced. In language education, digital platforms can expand access to authentic input, facilitate repeated practice, automate feedback, and create opportunities for interaction beyond the physical classroom. For Arabic, these possibilities are especially significant because learners must negotiate a language with a distinctive writing system, rich morphology, multiple registers, and strong connections between the linguistic form, culture, religion, and social context. Earlier work in Al-Tadris already positioned educational technology and e-learning as relevant to the modernisation of Arabic instruction, while more recent work has examined artificial intelligence and its pedagogical implications. (عارف الدين، ٢٠١٦ (توفيق، ٢٠١٦).

The contemporary technology landscape is considerably broader than the earlier e-learning environments. Mobile-assisted language learning, learning management systems (LMS), gamified platforms, artificial intelligence, automatic speech technologies, augmented and virtual reality, multimedia resources, and adaptive applications coexist in Arabic language education. Recent evidence shows, for example, that Duolingo and Memrise have been examined for Arabic phonology, morphology, and syntax, while other studies have explored Moodle, Google Classroom, gamification, and immersive technologies (Ritonga et al., 2022a) (Lubis & Nasution, 2025a) (Amran et al., 2026). This expansion creates a productive opportunity but also a

conceptual problem: the literature often evaluates individual tools without sufficiently explaining the pedagogical conditions under which these tools become educationally valuable.

Existing reviews provide important but fragmented perspectives on this topic. (Almelhes, 2024) systematically examined gamification for teaching Arabic to non-native speakers and reported positive associations with motivation, engagement, and vocabulary and grammar learning. Recent reviews have separately examined mobile-assisted language learning (Abdillah et al., 2026; Nurazizah et al., 2026), mobile innovations for imlā' instruction (Kusnawati et al., 2025a), digital game media (Zahra et al., 2026), interactive applications in secondary schools (Amalia & Marzuki, 2025), augmented reality in Malaysia (Amran et al., 2026), and virtual reality (Ziafia et al., 2026), while (Lubis & Nasution, 2025b) reviewed the effectiveness of technology integration. A 2025 review of technology integration into the Arabic language curriculum synthesised studies on emerging technologies, curriculum alignment, natural language processing, inclusive digital tools, and sociocultural dimensions. These contributions demonstrate the maturity of the field, but they also indicate that technology-enhanced Arabic education is developing through parallel strands rather than a unified pedagogical framework. As Table 1 shows, these reviews are typically bounded by a single technology, a single national or educational context, or a single skill; even the broader reviews concentrate on effectiveness or curriculum alignment rather than on how different technologies are linked to pedagogical functions, targeted Arabic skills, and implementation conditions within a single framework.

Therefore, this review does not simply address whether technology is useful. A more consequential question is how different digital tools are connected to language-learning purposes, instructional strategies, and measurable outcomes. The same tool may support very different learning processes depending on whether it is used for vocabulary exposure, communicative practice, formative assessment, collaborative writing, autonomous learning, or teacher-led scaffolding. In addition, positive outcomes reported in controlled or short-term studies cannot be automatically generalised to diverse educational contexts where teacher expertise, connectivity, device access, curriculum requirements, and Arabic-language content vary.

Consequently, the research gap is located at the intersection of technology typology and pedagogy. The existing literature contains evidence about individual technologies, but less synthesis is available that connects (1) the type and function of digital technology, (2) the pedagogical approach through which it is implemented, (3) the Arabic language skill or component targeted, (4) the reported learning outcome, and (5) the implementation conditions and risks. Addressing this gap is particularly important because recent AI-driven tools have introduced new questions about accuracy, contextual understanding, teacher roles, learner autonomy, ethics, and digital equity (Raswan et al., 2025).

Therefore, this study conducts a systematic literature review of technology-enhanced Arabic language teaching and learning. It asks four research questions: RQ1: What types of digital technologies have been used in Arabic language teaching and learning? RQ2: How are these technologies integrated into Arabic language pedagogical approaches and learning activities? RQ3: What learning outcomes and pedagogical benefits are most consistently

reported? RQ4: What challenges, limitations, and emerging research directions characterise the field? This review differs from previous reviews in three ways. First, whereas recent reviews have each addressed a single technology—MALL (Abdillah et al., 2026; Nurazizah et al., 2026), gamification and digital games (Almelhes, 2024), AR (Amran et al., 2026), or VR (Ziafia et al., 2026),—and LMS and AI have been examined mainly through single-platform or adoption studies (Ismail et al., 2023a); (Jm et al., 2025); (Raswan et al., 2025), this review synthesises all major technology categories within a single analytical frame. Second, it coded each study not only by technology type but also by pedagogical function, targeted Arabic skill, and implementation condition using TPACK as the coding lens. Third, it derives a technology-pedagogy-outcome framework that explains why the same tool may produce different results across contexts rather than treating technology as an independent intervention.

The significance of this review is both theoretical and practical. Theoretically, it proposes a technology-pedagogy-outcome perspective in which digital tools are understood in terms of what they enable teachers and learners to do with language. Practically, it provides a structured evidence base for Arabic language teachers, curriculum designers, educational technology developers, and researchers who need to select technologies according to instructional purposes rather than novelty. This orientation is consistent with Al-Tadris's emphasis on innovation in Arabic language learning and the journal's recent attention to AI and digital transformation in Arabic education.

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

Conceptualizing technology-enhanced Arabic language learning

Technology-enhanced language learning is best understood as the purposeful use of digital affordances to mediate language input, interaction, practice, feedback, assessment, and reflection. This definition avoids the equating of technology with innovation. A digital worksheet may reproduce a traditional exercise without changing the learning process, whereas a simple mobile recording activity may create substantially more opportunities for oral production. Therefore, the relevant analytical unit is the relationship between tool affordances and pedagogical activity.

For Arabic language education, this relationship has additional linguistic significance. Arabic instruction can involve the alphabet and orthography, vocabulary, morphology, syntax, phonology, listening, speaking, reading, writing, and pragmatic or sociocultural competence. Technology can support these domains in different ways. Text-based tools may be useful for reading and writing, audio and speech technologies for listening and pronunciation, adaptive exercises for morphology and vocabulary, collaborative platforms for writing and interaction, and immersive environments for contextualised speaking. Therefore, a systematic review must classify technologies by the learning functions they enable rather than simply by brand or platform.

The technology-pedagogy relationship can be interpreted through Technological Pedagogical Content Knowledge (TPACK), which emphasises the interaction of technological, pedagogical, and content knowledge (Mishra & Koehler, 2006). In Arabic education, content

knowledge includes not only linguistic forms but also register, culture, discourse conventions, and the distinctive relationship between written and spoken varieties of Arabic. Technology is pedagogically meaningful when teachers can connect content dimensions to suitable digital activities. Therefore, the framework helps explain why identical platforms may produce different outcomes in different classrooms. In this review, TPACK was operationalised as an analytical coding lens rather than a background theory. During data extraction, each included study was coded on three TPACK-aligned dimensions: technological knowledge (the tool and its affordances, such as automation, multimodality, and interactivity), pedagogical knowledge (the instructional strategy through which the tool was used, such as scaffolded practice, task-based communication, self-regulated learning, or blended sequencing), and content knowledge (the targeted Arabic skill or component, such as vocabulary, morphology, speaking, or writing). The intersections of these codes were then used to group studies and interpret outcomes, so that the reported effects were read as evidence of alignment or misalignment between technology, pedagogy, and content rather than as effects of the tool alone. This coding logic underlies the technology categories, pedagogical patterns, and technology-pedagogy-outcome synthesis reported in the Results section.

RESEARCH METHODS

This study adopted a systematic literature review (SLR) design with interpretive thematic synthesis. The reporting structure follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 framework, which emphasises the transparent reporting of identification, screening, eligibility, inclusion, and synthesis procedures (Page et al., 2021). This review synthesises empirical and review evidence concerning technologies used specifically for Arabic language teaching and learning. Because the research field is heterogeneous in terms of interventions, participants, outcomes, and designs, statistical meta-analysis was not assumed to be appropriate for all studies; instead, thematic synthesis was used to identify recurring patterns and relationships across the evidence.

The search was conducted in Scopus, Web of Science, ERIC, and Google Scholar on [VERIFY: search date], supplemented by backward and forward citation-checking. The core search concepts combine terms for Arabic language education with terms for technology and learning. A representative search string is as follows: ("Arabic language" OR "Arabic learning" OR "Arabic teaching" OR "Arabic as a foreign language") AND (technology OR "digital learning" OR "mobile-assisted language learning" OR MALL OR "learning management system" OR LMS OR gamification OR "artificial intelligence" OR chatbot OR "automatic speech recognition" OR "augmented reality" OR "virtual reality" OR "digital game" OR multimedia). The search strings were adapted to the syntax of each database.

The review protocol defines the following inclusion criteria: (1) peer-reviewed journal articles or research reports; (2) studies directly addressing Arabic language teaching or learning; (3) studies in which a digital or technology-mediated tool is an explicit part of the learning or teaching process; (4) empirical studies, systematic reviews, or rigorous review studies that provide analysable evidence; and (5) publications in English or Arabic. The preferred publication

window is 2015–2026 so that the review captures the transition from conventional e-learning to mobile, immersive, and AI-enabled learning. Studies were excluded when Arabic was only incidental, when technology was unrelated to the language-learning process, when the item was a non-scholarly web page, or when sufficient methodological information was unavailable.

Study selection proceeded through duplicate removal, title and abstract screening, full-text eligibility assessment, and final inclusion criteria. Two reviewers independently screened all records, resolved disagreements through discussion, and documented the reasons for exclusion at the full-text stage. Inter-reviewer agreement was calculated using Cohen's kappa before reconciliation (title/abstract screening: κ = [VERIFY]; full-text assessment: κ = [VERIFY]). This procedure reduced selection bias and strengthened the auditability of the review.

Data extraction was organised around bibliographic and pedagogical fields: author and year, country/context, educational level, learner population, technology type, platform/tool, language skill or component, pedagogical approach, research design, sample, learning outcomes, implementation conditions, limitations, and recommendations. Quality appraisal considered the clarity of research questions, methodological appropriateness, transparency of data collection, adequacy of analysis, and consistency between evidence and conclusions. The studies were then grouped into technology categories and cross-coded by pedagogical function and learning outcome.

The database search yielded [VERIFY] records. After [VERIFY] duplicates were removed, [VERIFY] records were screened by title and abstract, of which [VERIFY] were excluded from the study. [VERIFY] full-text reports were assessed for eligibility, and [VERIFY] were excluded for the following reasons (Arabic only incidental, n = [VERIFY]; technology unrelated to language learning, n = [VERIFY]; insufficient methodological information, n = [VERIFY]), resulting in [VERIFY] studies included in the final synthesis (Figure 1).

Table 1. Search and Synthesis Protocol

Element	Protocol for the review
Databases	Scopus; Web of Science; ERIC; Google Scholar; citation chaining
Publication window	2015–2026
Languages	English and Arabic
Core concepts	Arabic language education + digital/educational technology
Study types	Empirical studies and rigorous review studies
Synthesis	Thematic synthesis across technology, pedagogy, outcomes, and implementation conditions

Table 2. Eligibility Criteria

Inclusion	Exclusion
Directly concerns Arabic teaching/learning	Arabic only incidental to the study
Technology is part of the learning/teaching process	Technology unrelated to language learning
Peer-reviewed or rigorous research report	Non-scholarly web content
English or Arabic publication	Insufficient methodological information
2015–2026 preferred window	Outside the scope without strong justification

PRISMA 2020 SELECTION FLOW

Table 3. PRISMA 2020 Flow Diagram

Stage	Record count
Identification	Records identified from databases: [VERIFY]
Deduplication	Duplicates removed: [VERIFY]
Screening	Title/abstract records screened: [VERIFY]
Exclusion	Records excluded after screening: [VERIFY]
Eligibility	Full-text reports assessed: [VERIFY]
Full-text exclusion	Reports excluded with reasons: [VERIFY]
Included	Studies included in final synthesis: [VERIFY]

RESULTS AND DISCUSSION

Technology typology and the changing digital landscape

The reviewed literature shows that technology-enhanced Arabic language education can be organised into six overlapping categories: mobile-assisted learning, LMS and online learning environments, gamification and digital games, AI and intelligent language technologies, immersive and multimodal technologies, and digital content and assessment tools. These categories should not be understood as being mutually exclusive. A mobile application may incorporate gamification and adaptive feedback, an LMS may host AI-supported activities, and an immersive environment may combine multimedia, speech recognition, and collaborative tasks. Therefore, the value of typology is analytical rather than merely descriptive. These categories were derived inductively from the extraction matrices. Each included study was first coded by its primary technology and, where applicable, by secondary technologies; codes sharing core affordances and pedagogical functions were then clustered, and category labels were refined through reviewer discussion until every included study was assigned to at least one category. Because a study could contribute to more than one category, the category counts exceeded the total number of included studies: mobile-assisted learning ($n = [\text{VERIFY}]$), LMS and online learning environments ($n = [\text{VERIFY}]$), gamification and digital games ($n = [\text{VERIFY}]$), AI and intelligent language technologies ($n = [\text{VERIFY}]$), immersive and

multimodal technologies (n = [VERIFY]), and digital content and assessment tools (n = [VERIFY]).

Mobile-assisted learning is one of the most visible strands because smartphones combine portability, repeated exposure, multimedia input, and flexible practice. Evidence from the included studies suggests that mobile tools can support speaking, pronunciation, morphology, syntax, orthography, and learner autonomy. (Ritonga et al., 2022b) examined Duolingo as a platform for developing Arabic speaking skills in adult (andragogical) education; (Aedi et al., 2025) developed the An-Nasr mobile application to strengthen independent learning in Arabic instruction; and (Kusnawati et al., 2025b) reviewed mobile innovations for Arabic imlā' instruction. (Maghfurin et al., 2025) measured the effects of Duolingo and Memrise on the phonology, morphology, and syntax competence of Indonesian university students using a proficiency test, Likert-scale survey, and simple linear regression. Both apps produced significant gains, with Memrise showing a relative advantage in morphology and syntax, illustrating a shift from generic language-app use to the analysis of specific linguistic competencies. Mobile learning also appears in recent systematic reviews that emphasise accessibility and personalised practice (Abdillah et al., 2026; Nurazizah et al., 2026). However, mobile access alone does not guarantee pedagogical quality; distraction, uneven device access, limited depth of productive interaction, and dependence on pre-designed content remain important concerns.

LMS-based learning represents the second category. Moodle, Google Classroom, and Arabic-specific web environments can centralise materials, assignments, discussions, assessments, and feedback. Studies of Moodle, Google Classroom, and the web-based arabi.id platform (Jm et al., 2025), (Ismail et al., 2023b) indicate that LMS use can increase flexibility and support blended learning, but implementation is shaped by teachers' digital competence, infrastructure, Arabic-script compatibility, and the availability of appropriate content. The most productive use of LMS is therefore not simple content uploading; it is the organisation of sequenced learning activities in which learners receive input, produce language, obtain feedback, revise, and interact with peers and teachers. This observation reinforces the distinction between digital delivery and pedagogy.

Gamification and digital games constitute another strong area of research. (Almelhes, 2024), in a systematic review of 15 studies, found recurring evidence that gamified approaches can improve motivation, engagement, vocabulary, grammar, and participation among non-Arabic native learners. The reviewed studies used classroom, mobile, and online games, and game-based activities. The mechanism appears to involve immediate feedback, attainable goals, repetition, competition or collaboration, and visible progress. However, gamification can also reduce learning to points and rewards if game mechanics are disconnected from meaningful language use. Therefore, teachers need to align game tasks with linguistic objectives and maintain opportunities for explanation, interaction, and reflection.

Artificial intelligence is the most rapidly expanding category of technology. AI can support conversational practice, automated feedback, text generation, speech processing,

personalisation, and access to information. A recent Al-Tadris study reported that AI can improve efficiency and access to digital resources but also identified limitations in human interaction and contextual understanding (Raswan et al., 2025). The broader literature on Arabic education increasingly explores the use of generative AI, chatbots, automatic speech recognition, and natural language processing. These technologies create new possibilities for individualised practice, but their educational value depends on the accuracy of Arabic outputs, sensitivity to register and context, and teachers' ability to evaluate and mediate machine-generated content.

Immersive and multimodal technologies remain less established but are becoming increasingly visible. AR can connect vocabulary and language forms to contextualised visual objects, whereas VR can create simulated environments for interaction. Recent systematic reviews of AR (Amran et al., 2026), and VR (Ziafia et al., 2026) in Arabic language learning suggest that immersive technology is still underdeveloped compared to more established digital tools. This relative immaturity should not be interpreted as evidence of a low potential. Rather, it indicates a research opportunity: future studies should move beyond novelty demonstrations toward rigorous comparisons of immersive tasks with clearly defined, measurable communicative outcomes.

Pedagogical approaches underlying technology use

Four pedagogical patterns recur across technologies. The first is scaffolded practice, in which technology provides repeated exercises, examples, hints, or immediate feedback, while the teacher remains responsible for explanation and adjustment. The second is communicative and task-based learning, in which digital environments are used to create opportunities for meaningful language production. The third is autonomous and self-regulated learning, where learners control the timing, sequence, and intensity of practice. Fourth, blended learning, in which face-to-face teaching and digital activities are deliberately sequenced rather than treated as separate modes.

The evidence suggests that technology is most effective when embedded in a pedagogical sequence. For example, a vocabulary application may introduce lexical items, a gamified activity may provide retrieval practice, an LMS may collect learner production, and a teacher-led session may address errors and contextual use of the target language. In this model, technology performs complementary functions rather than replacing teachers. This principle is consistent with technological pedagogical content knowledge: teachers need knowledge of language content, pedagogy, and technology together rather than isolated technical skills (Mishra & Koehler, 2006).

Multimedia learning principles are also important. Digital materials can combine written Arabic, audio, images, animation, and video, but more media do not necessarily mean better learning outcomes. (Mayer, 2020) emphasises managing cognitive processing by coordinating words and visuals and avoiding unnecessary loads. For Arabic learners, this is particularly relevant when new scripts, pronunciations, translations, and visual cues are introduced simultaneously. Good digital pedagogy, therefore, requires selection and sequencing, not simply the accumulation of media.

Pedagogical evidence also points to the continuing importance of teacher presence. Digital environments can automate routine practices; however, teachers remain essential for contextualisation, corrective feedback, interactional modelling, affective support, and evaluation of machine-generated content. This is especially important for Arabic, as learners may encounter differences between Modern Standard Arabic, formal registers, and regional varieties. Technology that treats Arabic as a single uniform code may provide technically fluent but pedagogically incomplete inputs.

Learning outcomes and reported benefits

The most frequently reported benefits were engagement, motivation, accessibility, vocabulary development, language skill practice, feedback, and learner autonomy. Gamification studies particularly emphasise engagement and motivation (Almelhes, 2024), (Zahra et al., 2026), whereas mobile applications are often associated with flexible access and repeated practice (Maghfurin et al., 2025). LMS environments contribute to organisation, assignment management, and blended learning (Ismail et al., 2023a), (Jm et al., 2025). AI tools add the potential for personalisation and rapid feedback (Raswan et al., 2025). Nevertheless, these benefits should be interpreted carefully because many studies use short intervention periods, small samples, self-reported outcomes, or single institutional contexts.

Vocabulary is one of the clearest areas of benefit because digital tools can provide repetition, retrieval practice, images, audio and immediate feedback. However, vocabulary recognition should not be equated with lexical competence. Future evaluations should distinguish between recognition, recall, contextualised production, collocation, and communicative use. Similarly, speaking tools should be evaluated not only for pronunciation accuracy but also for interactional appropriateness and communicative effectiveness.

The literature also indicates that technology can support learner autonomy. Mobile applications permit learners to practice outside of class, while LMS dashboards can make progress visible. However, autonomy is not synonymous with independent access. Learners require digital literacy, self-regulation strategies, clear goals, and feedback. Thus, technology-mediated autonomy should be understood as supported autonomy, in which learners gain greater control while teachers design structures that make productive, self-directed learning possible.

Challenges, limitations, and equity

The first major challenge is the readiness of teachers. Studies across technology categories have repeatedly identified digital competence as a condition for successful implementation. Teachers need not become programmers, but they must be able to select tools, design tasks, interpret digital feedback, troubleshoot basic problems, and judge the quality of AI-generated- or platform-generated content. Therefore, professional development should focus on pedagogical use rather than generic software training.

The second challenge is infrastructure and digital inequalities. Connectivity, device availability, electricity, platform costs, and institutional technical support can shape whether an

apparently effective intervention is realistically scalable. Therefore, digital transformation can widen rather than reduce educational inequalities if access conditions are ignored. Systematic reviews should consider equity as an implementation variable rather than a peripheral ethical concern.

The third challenge is the Arabic-specific quality. Digital tools may vary in their treatment of Arabic scripts, diacritics, morphology, syntax, pronunciation, and dialectal variation. AI systems can generate grammatically plausible but contextually inappropriate output. Automated assessment may also privilege easily measurable forms over complex communication performance. Therefore, the development of Arabic educational technologies requires collaboration between language educators, linguists, instructional designers, and technology developers.

The fourth challenge concerns ethics and learner agency. AI-supported learning raises questions about privacy, data governance, authorship, over-reliance, hallucinated information, and the possibility that learners accept machine feedback uncritically. Consequently, the teacher's role should shift toward mediation and verification rather than disappearing. Responsible digital pedagogy should teach learners how to question, check, and improve machine-generated language.

Finally, the evidence base has methodological limitations. The literature is heterogeneous, and many studies are either small-scale or context-specific. Publication bias may have favoured positive findings. Motivation and engagement measures are often self-reported, while learning gains are sometimes measured immediately after an intervention. More longitudinal, comparative, multisite, and mixed-method research is needed to establish whether technology produces durable gains and under what conditions.

Emerging trends and research agenda

Five emerging directions are particularly important. First, generative AI is shifting technology research from content delivery to interactive language mediation. Future studies should examine how AI can support dialogue, feedback, writing revision, and differentiated instruction while preserving teacher oversight. Second, speech-enabled systems may increase opportunities for speaking and pronunciation practice; however, their accuracy across Arabic varieties requires rigorous evaluation. Third, adaptive systems can personalise difficulty and feedback, creating opportunities for self-regulated learning. Fourth, immersive technologies may provide contextualised communication environments. Fifth, analytics may connect learner activity data with instructional decision making.

The research agenda should also shift from tool-centered questions such as "Does application X work?" toward mechanism-centered questions such as "Which pedagogical mechanism does technology X activate, for which learners, for which Arabic skill, and under what conditions?" This change would improve theoretical coherence and reduce the rapid accumulation of isolated case studies in the literature. Studies should report sufficient implementation details so that other researchers can replicate the intervention.

A technology-pedagogy-outcome framework emerged from this synthesis. The first level includes technological affordances: access, interactivity, multimodality, automation, personalisation, immersion, and analytics. At the second level are pedagogical functions: explanation, scaffolding, practice, communication, feedback, assessment, collaboration, and self-regulation. The third level includes language outcomes: vocabulary, grammar, pronunciation, listening, speaking, reading, writing, and pragmatic competence. Contextual moderators—teacher competence, curriculum alignment, infrastructure, learner characteristics, language variety, and ethics—shaped the pathway between technology and outcomes. This framework provides a more useful basis for future empirical research than technology adoption alone does.

Table 3. Technology-Pedagogy-Outcome Synthesis

Technology category	Typical pedagogical functions	Likely Arabic learning targets	Key conditions
Mobile learning	Repeated practice, microlearning, self-paced learning	Vocabulary, pronunciation, morphology, reading	Access, distraction control, task design
LMS/online learning	Sequencing, assignment, feedback, blended learning	Integrated skills, writing, assessment	Teacher competence, infrastructure
Gamification/digital games	Retrieval practice, motivation, competition/collaboration	Vocabulary, grammar, reading, speaking	Alignment with language objectives
AI/NLP/chatbots	Personalization, dialogue, feedback, generation	Writing, speaking, vocabulary, grammar	Accuracy, contextualization, ethics
AR/VR/immersive	Contextualized interaction, visualization	Vocabulary, speaking, pragmatic competence	Hardware, instructional design
Multimedia/assessment tools	Multimodal input, formative assessment	Listening, reading, integrated skills	Cognitive load, feedback quality

Table 4. Priority Research Agenda

Research gap	Recommended future design
Small, short-term samples	Longitudinal and multi-site studies
Tool-centered evaluations	Mechanism-centered technology-pedagogy studies
Heavy reliance on self-report	Validated language proficiency measures
Limited Arabic-specific AI evaluation	Benchmarking accuracy across register and varieties
Underreported equity conditions	Report access, cost, connectivity, and inclusion
Limited reproducibility	Publish search strings, extraction matrix, and intervention details

CONCLUSION

This systematic literature review indicates that technology-enhanced Arabic language teaching and learning has moved from a relatively narrow emphasis on electronic delivery to a diverse ecosystem of mobile learning, LMS, gamification, artificial intelligence, immersive technologies, and multimodal resources. The most consistent benefits reported in the literature are engagement, accessibility, repeated practice, vocabulary development, feedback, and learner autonomy. However, the evidence does not support the conclusion that any specific technology is inherently superior. Rather, learning benefits are closely related to the pedagogical design through which technology is used in the classroom.

The central contribution of this review is the technology-pedagogy-outcome perspective. Digital tools should be evaluated according to the learning functions they enable, the pedagogical strategies that structure their use, and the language outcomes they yield. Teacher mediation remains essential, particularly when technology provides automated feedback or generative content. For Arabic education, this mediation must also address script, morphology, pronunciation, register, cultural context, and diversity of Arabic varieties.

Several recommendations are provided. Future research should use larger and more diverse samples, longitudinal designs, comparative conditions, validated language measures, and transparent descriptions of technological interventions. AI research should assess accuracy and contextual appropriateness, in addition to learner satisfaction. Mobile and gamified learning studies should distinguish motivation from durable language gain. Immersive technology research should link novelty to communicative outcomes. Researchers should also report infrastructure and equity conditions so that the evidence can be interpreted across contexts.

This review has some limitations. The search was restricted to English- and Arabic-language publications from 2015 to 2026 in four databases; therefore, relevant studies in other languages or non-indexed outlets may have been missed. The heterogeneity of the interventions and outcome measures precluded meta-analysis; therefore, the synthesis identified patterns rather than pooled effect sizes. Despite these limitations, this review provides a stronger evidence-based account of how technology can be integrated into Arabic language pedagogy without reducing educational innovation to technology adoption alone.

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Author Contribution Statement

First Author: conceptualisation, methodology, literature search, screening, data extraction, synthesis and manuscript drafting. International Co-author: methodological review, interpretation of findings, critical revision, and final approval of the manuscript.

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Declaration of AI Usage

The authors used ChatGPT to assist with language editing, structural organisation, and drafting. All generated content was reviewed, revised, fact-checked against the cited sources, and verified by the authors, who took full responsibility for the accuracy, originality, and integrity of the manuscript.

Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

The database search strings, screening records, and data extraction matrices are available from the corresponding author upon reasonable request.

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