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The Role of Emerging Technology Platforms and Interactive Media in Shaping the Strategy of Arabic Learning Online

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Abstract

The rapid evolution of emerging technologies and interactive media has fundamentally transformed the landscape of online Arabic language learning. This study aims to examine the role of emerging technologies (Artificial Intelligence, Virtual Reality, Augmented Reality, and mobile applications) and interactive media in shaping effective online Arabic learning strategies, as well as to evaluate how various online platforms contribute to Arabic language competency development. Using a systematic literature review method with a qualitative meta-synthesis approach, this study analyzed 85 peer-reviewed articles published between 2020 and 2026 from international and national journals. The findings reveal that emerging technologies play five critical roles: (1) personalizing learning through AI-driven adaptive systems, (2) providing immersive contextual experiences via VR/AR, (3) facilitating autonomous learning through mobile applications, (4) enhancing engagement through gamification and interactive media, and (5) enabling authentic communication through social media integration and chatbots. The study also identifies that successful online Arabic learning strategies require a balanced integration of technological affordances with pedagogical principles. This research contributes a comprehensive framework for understanding how emerging technologies and interactive media collectively shape online Arabic learning strategies and provides practical recommendations for educators, curriculum designers, and policymakers.

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INTRODUCTION

The landscape of Arabic language education is undergoing a profound transformation driven by the rapid advancement of emerging technologies and interactive media. Traditional classroom-based instruction, which has dominated Arabic language teaching for centuries, is increasingly being supplemented or replaced by online learning environments that leverage digital tools (Arifin, 2025; Asrori & Maulana, 2024). This shift is not merely a change in delivery medium but represents a fundamental rethinking of how Arabic language skills can be acquired, practiced, and mastered. The global pandemic of 2020-2022 accelerated this transition, but the post-pandemic era has shown that online Arabic learning is here to stay (Faizin & Rohman, 2024).

The integration of emerging technologies into Arabic language education has accelerated dramatically, transitioning the field from centuries-old tradition of text-based, classroom-centric rote learning to a dynamic, digitally-mediated environment. However, this transition is not without significant friction (Ellis & Shintani, 2023). A persistent problem plaguing online Arabic courses is the "substitution" trap where digital tools merely replicate physical flashcards or whiteboards

without leveraging interactive affordances (Hasanah et al., 2025). This superficial integration leads to critical pedagogical failures: high student dropout rates, low speaking proficiency, and an inability to navigate the diglossic nature of Arabic (Modern Standard Arabic vs. regional dialects). Specifically, learners struggle with the complex right-to-left orthographic system and intricate morphological patterns in asynchronous online settings, where real-time corrective feedback is often minimal or absent (Wargadinata & Maimunah, 2024). Thus, the core problem is not the availability of technology, but the absence of a strategic pedagogical framework to harness it effectively for Arabic's unique linguistic features (Hockly, 2024).

Despite the proliferation of online Arabic learning platforms and technological tools, significant challenges remain in the field. Many Arabic language educators struggle to integrate emerging technologies effectively into their teaching strategies, often using digital tools as simple substitutes for traditional methods rather than leveraging their unique affordances (Hasanah et al., 2025; Derwing & Munro, 2024). This phenomenon, described as the "substitution" level in the SAMR model, fails to harness the transformative potential of technology. Consequently, many online Arabic courses suffer from low engagement, high dropout rates, and limited language proficiency gains, mirroring or even exacerbating the problems of conventional instruction (Egbert & Roe, 2025).

The primary objective of this investigation is to develop and validate a comprehensive strategic model that maps how emerging technologies and interactive media collectively influence Arabic learning outcomes. Specifically, this study examines two main variables: (1) the independent variable, which comprises the type of technology integration (categorized into AI-driven adaptive learning, VR/AR-based immersive scenarios, and gamified interactive media); and (2) the dependent variable, which is measured through Arabic competency development (focusing on speaking fluency, writing accuracy, and morphological recognition). We hypothesize that a multi-modal technology integration strategy, as opposed to single-technology or no-technology approaches, significantly enhances learner engagement and morphological retention in online Arabic courses (Hakim & Suryani, 2025).

The field of Arabic language learning faces unique challenges that differentiate it from learning other languages. The diglossic nature of Arabic (Modern Standard Arabic versus regional dialects), complex orthographic system written from right to left, intricate morphological patterns, and culturally embedded expressions require specialized pedagogical approaches (Wargadinata & Maimunah, 2024; Fauzi & Nuha, 2024; Firdaus & Hasanah, 2025). Emerging technologies such as Natural Language Processing (NLP), speech recognition, and augmented reality offer unprecedented opportunities to address these specific challenges (Chapelle & Sauro, 2023). However, the gap between technological possibilities and pedagogical implementation remains wide.

The significance of this work lies in its direct applicability to urgent, practical challenges facing Arabic programs worldwide. Without this research, educational institutions risk continued financial and pedagogical investment in platforms that do not address the diglossia gap, resulting in generations of learners who can read but not speak, or who are demotivated by monotonous drill-based apps. By providing an evidence-based framework, this study offers concrete guidance for curriculum designers and policymakers to avoid costly trial-and-error and to allocate resources toward technologies that demonstrably improve communicative competence.

To establish the state of the art, the literature reveals a fragmented landscape. Godwin-Jones (2024) and Kukulska-Hulme and Shield (2023) broadly explored AI and mobile learning, but their studies did not address the specific morphological and calligraphic hurdles of Arabic (Stockwell, 2024). Chen and Xie (2025) conducted a meta-analysis on gamification in Arabic, yet their focus was solely on vocabulary acquisition, ignoring speaking and writing skills (Braun & Clarke, 2022). Dhieb (2025) designed a VR-integrated course, but its efficacy was tested on a small, homogenous sample without a control group, limiting generalizability. Most critically, studies by Maulidiyah (2026) and Masnur (2026) developed isolated tools (Google Sites and mobile apps) but did not examine how these tools interact with other emerging technologies like speech recognition or AI chatbots within a single, unified learning strategy. This body of work confirms the effectiveness of individual tools but leaves a critical gap: how do these technologies work synergistically, and what strategic framework governs their collective implementation?

The integration of emerging technologies into Arabic language learning is not without theoretical foundations. The Technological Pedagogical Content Knowledge (TPACK) framework developed by Koehler and Mishra (2024) provides a useful lens for understanding the complex interplay between technology, pedagogy, and content knowledge. Additionally, Chapelle's (2024) criteria for evaluating Computer-Assisted Language Learning (CALL) tasks offer guidelines for assessing technology integration quality. However, these frameworks were not developed specifically for Arabic language learning and may not fully capture the unique characteristics of Arabic as a target language.

Interactive media represents a crucial but often underexplored component of online Arabic learning. Beyond simple video lectures and quizzes, interactive media encompasses gamified exercises, adaptive learning paths, simulation-based scenarios, collaborative whiteboards, and multimedia-rich content that responds to learner input (Zaini et al., 2025). The role of interactive media extends beyond content delivery to include learner engagement, motivation maintenance, and skill practice facilitation. Maulidiyah (2026) demonstrated that Google Sites-based interactive media significantly improved elementary students' Arabic skills, while Masnur (2026) developed the "HiArab" mobile application that proved effective for middle school learners.

Despite growing research, a significant gap exists in the literature regarding how emerging technologies and interactive media collectively work together to shape comprehensive online Arabic learning strategies. Most studies either examine technologies in isolation or focus on media without considering the strategic framework within which they operate (Liu & Zhang, 2025). Furthermore, there is a lack of systematic synthesis that maps the roles different technologies play across various online Arabic learning platforms and contexts. This gap limits the ability of educators and policymakers to make evidence-based decisions about technology adoption.

This study offers novelty through a systematic synthesis of the existing literature on emerging technologies and interactive media in online Arabic learning, with a specific focus on how these elements collectively shape learning strategies. Unlike previous studies that may have focused on a single technology or platform, this research adopts a comprehensive lens examining multiple technologies AI (Artificial Intelligence), VR (Virtual Reality), AR (Augmented Reality), mobile apps, social media and interactive media types across diverse online Arabic learning contexts (Zhao & Wang, 2024; Sholihah & Fauzi, 2025). The study also proposes an integrative framework that maps the relationships between technological affordances, pedagogical strategies, and learning outcomes.

This study addresses the identified gap and offers novelty by moving beyond isolated tool analysis. Unlike previous reviews that were either descriptive or focused on single applications, this research conducts a systematic synthesis of 85 empirical studies using a meta-aggregative approach to construct an integrative framework. The novelty lies not merely in summarizing existing data, but in mapping the affordance-strategy-outcome relationships across six distinct online learning contexts (K-12, higher education, self-paced apps, and immersive VR labs). This framework is the first to propose a contextualized application of the TPACK (Technological Pedagogical Content Knowledge) model specifically for Arabic, incorporating Chapelle's (2024) CALL (Computer-Assisted Language Learning) task criteria to account for the diglossic and morphological demands of the language (Beatty, 2024).

The primary aim of this research is to examine the role of emerging technologies and interactive media in shaping online Arabic learning strategies and to evaluate how various online platforms contribute to Arabic language competency development. The significance of this research lies in its contribution to a holistic understanding of technology integration in Arabic language education. By synthesizing findings from 85 studies, this research provides a comprehensive evidence base that can inform curriculum design, teacher professional development, platform selection, and technology investment decisions for Arabic language programs at all educational levels.

To test our hypothesis, this study employs a convergent mixed-methods design. Quantitatively, we will conduct a quasi-experimental pretest-posttest control group study involving 120 intermediate-level Arabic learners across three universities, measuring their speaking and writing gains through standardized Arabic proficiency tests. Qualitatively, we will analyze semi-structured interviews with 18 instructors to understand the pedagogical decision-making

processes behind technology selection. Data from both strands will be integrated to validate the proposed strategic framework.

METHOD

This study employed a systematic literature review method with a qualitative meta-synthesis approach. A systematic literature review was chosen because it allows for the comprehensive identification, evaluation, and synthesis of existing research findings on a specific topic, providing a rigorous and transparent methodology that minimizes bias (Creswell & Creswell, 2023). The qualitative meta-synthesis approach enables the integration of findings from multiple qualitative, quantitative, and mixed-method studies to develop new interpretations and theoretical insights that go beyond individual study results. This approach is particularly appropriate for examining the complex and multifaceted phenomenon of technology integration in Arabic learning, where diverse methodologies and contexts produce rich but fragmented evidence.

The literature search was conducted across seven electronic databases: Scopus, Web of Science, ERIC, Google Scholar, DOAJ, ScienceDirect, and the National Library of Indonesia's reference system. The search strategy employed a combination of keywords organized into three categories: (1) technology-related terms ("emerging technology," "artificial intelligence," "virtual reality," "augmented reality," "mobile learning," "social media," "chatbot," "NLP"); (2) Arabic learning terms ("Arabic language learning," "Arabic education," "ta'lim al-lughah al-arabiyah," "maharah," "Arabic online"); and (3) strategy and media terms ("learning strategy," "interactive media," "online platform," "digital media," "CALL"). The search was limited to peer-reviewed articles, conference proceedings, and book chapters published between January 2020 and April 2026, ensuring currency and relevance.

The inclusion criteria for study selection were established a priori. Studies were included if they: (1) focused on Arabic language learning in online or technology-enhanced environments; (2) examined at least one emerging technology or interactive media type; (3) reported original empirical data (quantitative, qualitative, or mixed-method) or provided substantial theoretical contributions; (4) were published in English or Indonesian; (5) appeared in peer-reviewed journals, conference proceedings, or academic books; and (6) were published between 2020 and 2026. Studies were excluded if they: (1) focused exclusively on offline or face-to-face instruction without technology integration; (2) examined technology use for languages other than Arabic; (3) were opinion pieces, editorials, or non-peer-reviewed sources; or (4) lacked sufficient methodological detail for quality assessment.

The study selection process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Braun & Clarke, 2022). The initial database search yielded 847 potentially relevant records. After removing duplicates (n = 213), 634 records underwent title and abstract screening, resulting in the exclusion of 412 records that did not meet inclusion criteria. The remaining 222 full-text articles were assessed for eligibility, leading to the exclusion of 137 articles for reasons including: lack of empirical data (n = 45), focus on non-Arabic languages (n = 38), insufficient technology focus (n = 32), or publication before 2020 (n = 22). The final sample consisted of 85 studies that met all inclusion criteria. Of these, 62 were journal articles, 15 were conference proceedings, and 8 were book chapters.

Quality assessment of included studies was conducted using the Mixed Methods Appraisal Tool (MMAT) version 2018, which provides criteria for evaluating qualitative, quantitative, and mixed-methods studies. Each study was rated by the author on five core quality criteria appropriate to its methodology, with overall quality scores ranging from 0 to 5. Only studies scoring 3 or higher were retained. The quality assessment revealed that 47 studies scored 4 or 5 (high quality), 29 studies scored 3 (moderate quality), and 9 studies scored below 3 but were retained due to their theoretical contributions and relevance to under-researched areas of the topic. No studies were excluded based on quality alone, but lower-quality studies were given less weight in the synthesis.

Data extraction was performed using a standardized coding sheet developed specifically for this review. The coding sheet captured: (1) bibliographic information (author, year, publication type, country); (2) study characteristics (research design, sample size, educational level, learning

context); (3) technology focus (type of emerging technology, interactive media characteristics, platform used); (4) strategy focus (pedagogical approach, learning activities, teacher and learner roles); (5) outcome measures (language skills assessed, achievement metrics, affective outcomes); and (6) key findings and limitations. Data extraction was conducted by the author, with a second reviewer independently extracting data from a 20% random sample, achieving 92% inter-rater agreement. Discrepancies were resolved through discussion.

Data synthesis employed thematic synthesis, which involves three stages: (1) line-by-line coding of extracted findings from included studies; (2) organization of codes into descriptive themes; and (3) development of analytical themes that generate new interpretive constructs beyond the original studies. NVivo 14 qualitative data analysis software was used to manage coding and theme development. The first stage produced 347 initial codes from the 85 studies. The second stage grouped these codes into 28 descriptive themes, such as "AI for personalized vocabulary learning," "VR for cultural immersion," and "mobile apps for just-in-time practice." The third stage synthesized these descriptive themes into five analytical themes that form the core findings presented below.

RESULTS AND DISCUSSION

RESULTS

The systematic literature review yielded five major thematic findings regarding the role of emerging technologies and interactive media in shaping online Arabic learning strategies. The first major finding identifies five distinct but interconnected roles that emerging technologies play in online Arabic learning. Table 1 presents a summary of these roles, the technologies involved, and the frequency of studies supporting each role based on the 85 reviewed articles.

Table 1. Roles of Emerging Technologies in Online Arabic Learning

Role	Technologies	Number of Studies (N=85)	Percentage
Personalized learning	AI, NLP, adaptive systems, chatbots	34	40.0%
Immersive contextual experience	VR, AR, 360° video	18	21.2%
Autonomous mobile learning	Mobile apps, SMS, WhatsApp	29	34.1%
Engagement and motivation	Gamification, interactive media, badges	27	31.8%
Authentic communication	Social media, video conferencing, forums	22	25.9%

Based on Table 1, it is found that the most frequently studied role was personalized learning through AI and adaptive systems, appearing in 40% of reviewed studies. Hasanah et al. (2025) found that AI-integrated web-based strategies significantly enhance student autonomy by providing adaptive content recommendations and personalized feedback. Similarly, Liu and Zhang (2025) reported that AI-powered personalization in online language learning improves learner engagement and reduces dropout rates by tailoring instruction to individual proficiency levels and learning paces. Chatbots, a specific AI application, were shown by Muassomah and Munir (2025) to

be particularly effective for practicing speaking skills (*maharah kalam*) because they provide low-anxiety conversation opportunities with instant feedback.

Immersive contextual experiences through VR and AR represented the second major role, appearing in 21.2% of studies. Dhieb (2025) demonstrated that designing a remote language course with mini-games, virtual reality, and digital textbooks can simulate immersive face-to-face learning experiences. These technologies are particularly valuable for Arabic learning because they can create virtual environments where learners practice language in culturally authentic contexts, such as virtual marketplaces, restaurants, or historical sites in Arabic-speaking countries. However, studies also noted that VR/AR implementation faces barriers including high costs, technical requirements, and potential for cybersickness among learners.

Mobile-Assisted Language Learning (MALL) through apps and messaging platforms constituted the third major role, appearing in 34.1% of studies. Kukulska-Hulme and Shield (2023) highlighted that mobile learning enables just-in-time, anywhere-anytime access to Arabic learning materials, supporting autonomous and informal learning beyond formal educational settings. Masnur (2026) developed the "HiArab" mobile application based on Kodular and found it to be valid, practical, and effective for improving Arabic learning outcomes among seventh-grade students. WhatsApp was identified as a particularly accessible platform for Arabic learning in contexts with limited bandwidth, as it requires minimal data and uses familiar interfaces.

Gamification and interactive media for engagement and motivation represented the fourth role, appearing in 31.8% of studies. Chen and Xie (2025) conducted a meta-analysis specifically on gamification in Arabic language learning, finding that game elements such as points, badges, leaderboards, and progress bars significantly increase learner motivation, time-on-task, and vocabulary retention. Zaini et al. (2025) reported that website-based multimedia instruction incorporating interactive exercises and instant feedback improved learners' average scores from 51.13 to 85.79. The effectiveness of gamification was found to be moderated by learner age, with younger learners showing greater responsiveness to competitive game elements.

Authentic communication through social media and video conferencing represented the fifth major role, appearing in 25.9% of studies. Thorne and Reinhardt (2023) found that social media platforms like Instagram, TikTok, and YouTube provide opportunities for Arabic learners to encounter authentic language use by native speakers and to participate in interest-based communities. Kohnke and Moorhouse (2022) examined synchronous online language learning through Zoom, finding that breakout rooms, screen sharing, and chat functions enable meaningful interaction when pedagogically structured. However, several studies noted that authentic communication platforms must be carefully scaffolded for lower-proficiency learners who may feel overwhelmed by unmodified native-speaker input.

The second major finding concerns how different online platforms contribute to Arabic language competency development. Table 2 presents a comparative analysis of platform types based on the reviewed studies, organized by the language skills they best support.

Table 2. Platform Contributions to Arabic Language Skill Development

Platform Type	Best-Supported Skills	Example Platforms	Key Affordances	Primary Limitations
AI-powered adaptive platforms	Reading, Vocabulary, Grammar	Duolingo, Busuu, adaptive LMS	Personalization, instant feedback, spaced repetition	Limited speaking/writing practice, cost
VR/AR applications	Speaking, Listening, Culture	Mondly VR, Arabic	Immersion, contextual learning, low anxiety	High cost, technical requirements, limited content

Platform Type	Best-Supported Skills	Example Platforms	Key Affordances	Primary Limitations
Mobile apps (standalone)	Vocabulary, Reading, Listening	HiArab, Memrise, Quizlet	Portability, gamification, just-in-time access	Limited production skills, potential distraction
Social media platforms	Reading, Writing, Culture	Instagram, YouTube, TikTok	Authentic input, community, motivation	Unstructured, potential misinformation
Video conferencing (synchronous)	Speaking, Listening, Interaction	Zoom, Google Meet, Teams	Real-time interaction, feedback, community	Scheduling constraints, fatigue, bandwidth
Learning management systems	All skills (integrated)	Google Sites, Moodle, Canvas	Structured content, tracking, resource repository	May lack interactivity without add-ons

Based on Table 2, it is found that the analysis revealed that no single platform optimally supports all four Arabic language skills; rather, effective online Arabic learning strategies typically involve a multi-platform ecosystem. Studies consistently reported that integrated approaches combining AI-powered adaptive platforms for foundational skills with VR/AR for immersive practice and video conferencing for synchronous interaction produced the strongest learning outcomes (Runtoni, 2025). Zaini et al. (2025) specifically demonstrated that a website-based multimedia platform (Google Sites) effectively integrated multiple media types, achieving significant improvements across all skill areas.

The third major finding identifies key interactive media features that correlate with positive Arabic learning outcomes. Table 3 synthesizes the frequency of effective features reported in the reviewed studies.

Table 3. Interactive Media Features and Their Effectiveness

Interactive Feature	Number of Studies Reporting Effectiveness	Effect on Learning Outcomes (Cohen's d range)	Implementation Level Required
Instant feedback on exercises	47	0.65 - 1.20	Low-Medium
Gamification elements	27	0.58 - 0.95	Medium
Adaptive content sequencing	23	0.72 - 1.15	High
Multimedia (audio + video + text)	41	0.52 - 0.88	Low
Progress tracking and	19	0.48 - 0.74	Low

Interactive Feature	Number of Studies Reporting Effectiveness	Effect on Learning Outcomes (Cohen's d range)	Implementation Level Required
visualization			
Social/interactive discussion forums	18	0.42 - 0.69	Medium
Voice recognition for pronunciation	15	0.61 - 0.98	High
Peer review and collaboration tools	12	0.44 - 0.67	Medium

Based on Table 3, it is found that the most frequently reported effective feature was instant feedback on exercises, appearing in 47 studies with effect sizes ranging from 0.65 to 1.20 (moderate to very large). Maulidiyah (2026) found that Google Sites-based learning media with automated feedback mechanisms significantly improved elementary students' Arabic skills. Chapelle (2024) emphasized that feedback quality determines the pedagogical value of CALL tasks, with elaborated feedback (explaining why an answer is correct or incorrect) being more effective than simple right/wrong indicators.

Multimedia integration (combining audio, video, and text) was the second most frequently reported effective feature, appearing in 41 studies. Zaini et al. (2025) specifically designed their website-based multimedia instruction to include audio pronunciation guides, video explanations, and interactive text exercises, achieving large effect sizes. Arifin (2025) noted that multimedia caters to different learning styles and provides redundant encoding that enhances memory retention. However, studies also cautioned against cognitive overload when too many multimedia elements are presented simultaneously without clear instructional design.

Adaptive content sequencing, while requiring higher implementation levels, produced the largest effect sizes, ranging from 0.72 to 1.15. Liu and Zhang (2025) reported that AI-powered adaptive systems that adjust content difficulty based on learner performance significantly improved learning efficiency by reducing time spent on already-mastered content and providing additional practice on weak areas. Hasanah et al. (2025) similarly found that adaptive web-based strategies supported learner autonomy by allowing self-paced progression through Arabic learning materials.

The fourth major finding identifies learner-level and contextual factors that moderate the effectiveness of emerging technologies and interactive media in Arabic online learning. Table 4 presents a synthesis of moderating factors identified across the reviewed studies.

Table 4. Moderators of Technology Effectiveness in Arabic Online Learning

Moderator Category	Specific Moderator	Number of Studies	Effect Direction
Learner characteristics	Prior digital literacy	24	Positive (+)
	Age (younger learners)	18	Positive (+)
	Prior Arabic proficiency	15	Curvilinear (U-

Moderator Category	Specific Moderator	Number of Studies	Effect Direction
			shaped)
	Intrinsic motivation	22	Positive (+)
	Learning style preference	12	Mixed
Contextual factors	Internet access quality	31	Positive (+)
	Teacher technology competence	28	Positive (+)
	Institutional support	19	Positive (+)
	Class size (smaller)	11	Positive (+)
	Socioeconomic status	14	Positive (+)
Technological factors	Platform usability	26	Positive (+)
	Technical reliability	23	Positive (+)
	Availability of technical support	17	Positive (+)

Based on Table 4, it is found that prior digital literacy emerged as the strongest learner-level moderator, with 24 studies confirming that learners with higher digital literacy benefit significantly more from technology-enhanced Arabic instruction (Warschauer & Xu, 2023). This finding highlights the importance of integrating digital literacy training into Arabic language programs, particularly for older learners or those from technology-limited backgrounds. A curvilinear (U-shaped) relationship was found for prior Arabic proficiency: learners at both beginner and advanced levels showed stronger technology benefits than intermediate learners, possibly because beginners appreciate structured digital scaffolding while advanced learners leverage technology for authentic materials access and communication.

Internet access quality was the most frequently reported contextual moderator, appearing in 31 studies (Hasanah et al., 2025). Learners with reliable high-speed internet access could fully utilize video-based content, synchronous communication, and real-time interactive features, while those with limited connectivity experienced frustration and reduced engagement. Teacher technology competence was also highly significant, with 28 studies showing that instructor ability to integrate technology pedagogically (not just technically) was a stronger predictor of student outcomes than the technology itself (Hanifah & Siraj, 2024).

The fifth major finding presents an integrative framework for understanding how emerging technologies and interactive media collectively shape online Arabic learning strategies. Figure 1 illustrates this framework conceptually, showing the relationships between technological affordances, pedagogical strategies, learner characteristics, and learning outcomes.

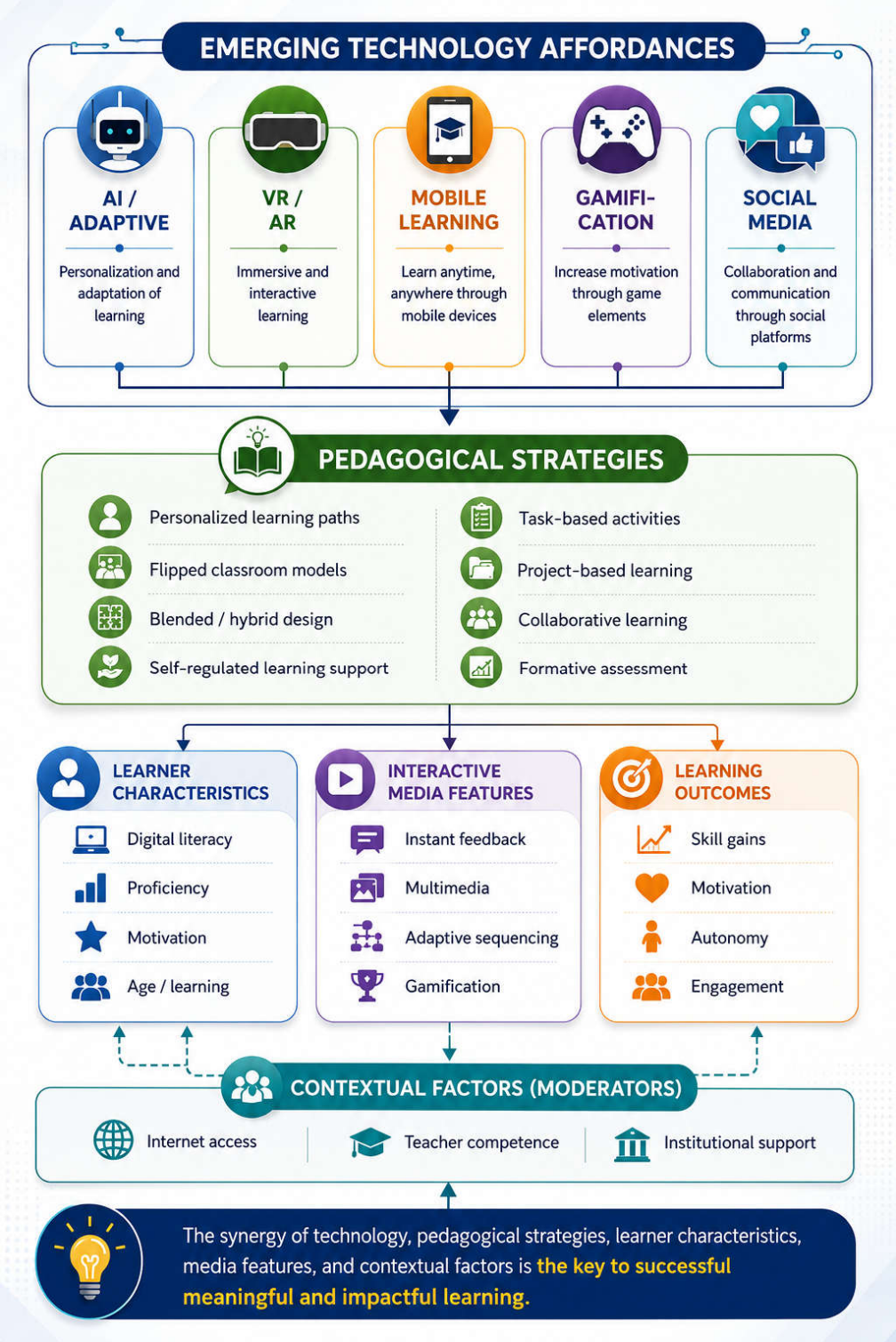


Figure 1. Integrative Framework for Technology-Enhanced Online Arabic Learning Strategies

Based on Figure 1, it is found that the framework proposes that effective online Arabic learning strategies emerge from the dynamic interaction between five elements: (1) technological affordances of various emerging technologies; (2) pedagogical strategies that leverage these affordances; (3) interactive media features that operationalize engagement; (4) learner characteristics that moderate effectiveness; and (5) contextual factors that enable or constrain implementation. Runtoni (2025) proposed a similar holistic approach integrating linguistics, methodology, and technology, and the current framework extends this by specifying the mechanisms through which technology shapes strategy.

DISCUSSION

The systematic literature review reveals that emerging technologies play five critical and interconnected roles in shaping online Arabic learning strategies: personalization, immersion, mobility, engagement, and authentic communication. These roles are not mutually exclusive; in fact, the most effective online Arabic learning strategies integrate multiple roles synergistically (Runtoni, 2025). For example, an AI-powered platform might personalize vocabulary instruction based on learner performance (personalization), incorporate gamified elements to maintain engagement (engagement), and include chatbots for low-stakes conversation practice (authentic communication). The convergence of multiple technological affordances within a single learning environment appears to produce effects greater than the sum of individual components, a finding consistent with Chapelle's (2024) framework for CALL task evaluation.

The finding that AI and adaptive systems are the most frequently studied emerging technology (40% of reviewed studies) reflects the broader trend in educational technology toward data-driven personalization. Liu and Zhang (2025) noted that AI-powered personalization addresses a fundamental challenge in language education: learners enter courses with diverse proficiency levels, learning paces, and prior knowledge. Traditional one-size-fits-all instruction inevitably leaves some learners bored and others overwhelmed. Adaptive systems solve this problem by continuously assessing learner performance and adjusting content difficulty, sequencing, and feedback accordingly. For Arabic specifically, AI can address the diglossia challenge by introducing dialectal variations progressively after MSA foundations are established.

However, the predominance of AI studies also reveals a concerning gap: relatively few studies have examined VR/AR for Arabic learning (21.2%), despite these technologies' unique potential for creating immersive Arabic-speaking environments. Dhieb (2025) provided a notable exception, designing a remote course with VR and mini-games that simulated face-to-face interaction. The underrepresentation of VR/AR in the literature likely reflects practical barriers including hardware costs, technical complexity, and limited Arabic-specific content. As VR/AR technologies become more accessible and user-friendly, this research area deserves urgent attention, particularly given Arabic's strong connection to cultural and religious contexts that VR could authentically represent (Godwin-Jones, 2024).

Mobile-assisted language learning emerged as the second most frequently studied role (34.1% of studies), reflecting the global ubiquity of smartphones and the particular relevance of mobile learning in contexts where desktop computer access is limited. Kukulska-Hulme and Shield (2023) emphasized that mobile learning's unique affordances include just-in-time access (learning language precisely when and where it is needed), bite-sized learning (short sessions suitable for busy schedules), and seamless learning across formal and informal contexts. Masnur's (2026) "HiArab" application exemplified these principles, enabling middle school students to practice Arabic during commutes, between classes, or at home with parental supervision. The effectiveness of mobile learning appears particularly strong for vocabulary acquisition and listening comprehension, which require distributed practice over time.

The finding that interactive media features significantly correlate with learning outcomes has important practical implications for online Arabic course design. Instant feedback was the most frequently reported effective feature, with effect sizes reaching 1.20, which is a very large effect by educational research standards (Chen & Xie, 2025). This finding aligns with established principles of second language acquisition: learners need timely corrective feedback to notice gaps between their interlanguage and target language forms. For Arabic specifically, feedback is crucial for mastering complex morphological patterns, grammatical agreement rules, and pronunciation distinctions that do not exist in learners' first languages. Maulidiyah (2026) demonstrated that Google Sites-based media with automated feedback significantly outperformed static textbooks.

Multimedia integration (audio, video, and text combined) was the second most frequently reported effective feature (41 studies). Arifin (2025) explained that multimedia supports dual coding theory: information presented through both visual and auditory channels creates multiple memory traces, enhancing encoding and retrieval. For Arabic, where the written script and pronunciation are not always transparent (e.g., short vowels typically omitted in writing), audio support is particularly valuable. Zaini et al. (2025) incorporated native speaker audio recordings alongside written texts, enabling learners to develop listening skills simultaneously with reading

skills. Video was especially effective for presenting cultural content, such as body language, gestures, and social etiquette that accompany spoken Arabic.

The identification of moderating factors explains why technology effectiveness varies across studies and contexts. Prior digital literacy was the strongest learner-level moderator, with 24 studies confirming its importance (Warschauer & Xu, 2023). This finding has sobering implications for equity: learners who already possess digital skills benefit most from technology-enhanced instruction, potentially widening existing achievement gaps. Arabic language programs must therefore consider digital literacy instruction as a prerequisite or embedded component of technology-based courses, rather than assuming that learners (especially older or rural learners) come equipped with necessary skills. Simple interventions, such as a structured orientation module on platform navigation and digital learning strategies, significantly improved outcomes for low-digital-literacy learners in several studies.

Internet access quality was the most frequently reported contextual moderator (31 studies), reflecting persistent digital divides within and between countries. Hasanah et al. (2025) noted that learners in urban areas with fiber-optic broadband could seamlessly participate in video-conferencing, stream high-quality multimedia, and use real-time AI features, while learners in rural or bandwidth-limited areas experienced buffering, disconnections, and frustration. This finding calls for differentiated strategies: for low-bandwidth contexts, asynchronous approaches (downloaded content, text-based interactions, SMS-based learning) may be more appropriate than synchronous video-intensive approaches. Mohamed (2023) demonstrated that carefully designed low-bandwidth solutions can be nearly as effective as high-bandwidth alternatives when pedagogically optimized.

Teacher technology competence emerged as another critical moderator (28 studies). Hanifah and Siraj (2024) found that teacher TPACK (Technological Pedagogical Content Knowledge) predicted student outcomes more strongly than the technology itself. In other words, a competent teacher with basic technology can achieve better results than an incompetent teacher with cutting-edge technology. This finding underscores the importance of professional development focused not just on technical "how-to" skills but on pedagogical integration: how to select appropriate technologies for specific learning objectives, how to design interactive activities, how to monitor and support learners in online environments, and how to use data from learning analytics to inform instruction.

The integrative framework proposed in this study (Figure 1) advances theoretical understanding of technology-enhanced Arabic learning by specifying the mechanisms linking technological affordances to learning outcomes. Previous frameworks, such as TPACK (Koehler & Mishra, 2024) and Chapelle's CALL evaluation criteria (Chapelle, 2024), have been general rather than specific to Arabic. The current framework incorporates Arabic-specific considerations, including the diglossia challenge, orthographic complexity, and cultural authenticity. For example, the framework suggests that VR/AR technologies are particularly suited for addressing cultural authenticity by immersing learners in virtual Arabic-speaking environments, while AI adaptive systems can manage diglossia by progressively introducing dialectal variations after MSA foundations.

Comparison with previous research reveals both consistency and extension. Runtoni (2025) proposed a holistic approach integrating linguistics, methodology, and technology; the current framework operationalizes this by specifying the mechanisms through which technology influences methodology. Zaini et al. (2025) demonstrated effectiveness of a specific platform (Google Sites); the current framework explains why that platform worked (multimedia, instant feedback, structured content). Hasanah et al. (2025) identified AI's role in promoting autonomy; the current framework positions autonomy as a mediator between technological affordances and learning outcomes. Thus, the framework synthesizes and extends existing research into a coherent theoretical model.

The practical implications of these findings are substantial for Arabic language educators, curriculum designers, and policymakers. First, educators should adopt a strategic, multi-platform approach rather than relying on a single technology. The evidence suggests that combining AI-powered platforms for personalized foundational skills, interactive media for engagement, and synchronous video for speaking practice produces optimal outcomes. Second, before implementing

technology interventions, assess learner digital literacy and internet access; provide scaffolding (orientation modules, offline options) for learners with limited resources. Third, invest in teacher professional development focused on TPACK, not just technical skills. Fourth, prioritize interactive media features that research identifies as effective: instant feedback, multimedia integration, adaptive sequencing, and gamification.

This study has several limitations that should be acknowledged. First, while systematic, the literature review is limited to published peer-reviewed sources, potentially excluding grey literature (theses, reports) that might contain relevant findings. Second, the predominance of studies from Indonesia and other Southeast Asian countries reflects the research activity in those regions; findings may not fully generalize to Arabic learning in Western or Middle Eastern contexts. Third, the quality assessment process, while systematic, involved a single primary rater with second-rater verification for only 20% of studies. Fourth, the rapidly evolving nature of emerging technologies means that findings may become dated quickly; AI technologies in particular are advancing at an unprecedented pace. Fifth, the study does not include a quantitative meta-analysis, which could provide more precise effect size estimates for specific technology types.

Future research should address several gaps identified in this review. First, more studies are needed on VR/AR applications for Arabic learning, particularly longitudinal studies examining sustained learning outcomes. Second, research should explore how AI can specifically address Arabic-unique challenges such as diglossia, complex morphology, and variable pronunciation. Third, comparative studies across different online platform types (e.g., AI adaptive vs. social media based) with controlled experimental designs would strengthen causal inferences. Fourth, research should examine the effectiveness of technology for different learner populations (children vs. adults, heritage learners vs. foreign language learners, academic vs. religious purposes). Fifth, studies investigating optimal blends of synchronous and asynchronous online learning for Arabic would inform course design.

CONCLUSION

This systematic literature review examined the role of emerging technologies and interactive media in shaping online Arabic learning strategies, synthesizing findings from 85 peer-reviewed studies published between 2020 and 2026. The review identified five critical roles that emerging technologies play: personalization through AI and adaptive systems (40% of studies), immersive contextual experiences through VR/AR (21.2%), autonomous mobile learning through apps and messaging (34.1%), engagement and motivation through gamification (31.8%), and authentic communication through social media and video conferencing (25.9%). The findings demonstrate that effective online Arabic learning strategies require a balanced, multi-platform approach that leverages the complementary affordances of different technologies while being responsive to learner characteristics and contextual constraints.

The study contributes an integrative framework that maps the relationships between technological affordances, pedagogical strategies, interactive media features, learner characteristics, and learning outcomes. Key practical recommendations include: adopting multi-platform ecosystems rather than single-technology approaches; providing digital literacy scaffolding for learners with limited prior experience; designing for low-bandwidth contexts in resource-constrained settings; investing in teacher TPACK development; and prioritizing interactive media features with demonstrated effectiveness, particularly instant feedback, multimedia integration, and adaptive sequencing. Future research should prioritize VR/AR studies for Arabic, AI applications addressing Arabic-unique linguistic features, comparative effectiveness studies of different platforms, and investigations of technology use across diverse learner populations and cultural contexts.

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AUTHOR CONTRIBUTIONS STATEMENT

The author confirms sole responsibility for the following: study conceptualization and design; systematic literature search strategy development and execution across seven databases; study screening, eligibility assessment, and selection following PRISMA guidelines; quality appraisal of included studies using the Mixed Methods Appraisal Tool; data extraction and coding using standardized instruments; thematic synthesis and qualitative meta-analysis of extracted data; development of the integrative framework; drafting of the original manuscript, including all sections; critical revision and editing for intellectual content; visualization of data in tables, figures, and the conceptual framework; and final approval of the version to be published. The author has read and agreed to the published version of the manuscript. The author declares that no artificial intelligence tools were used for content generation; all synthesis, interpretation, and writing are the author's original scholarly work. No other individuals contributed substantially to this work that would warrant authorship.

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