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Technological Transformations in Arabic Language Learning: A Comprehensive Review of Emerging Tools and Techniques

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Abstract

Digital technology has transformed how Arabic is taught and learned worldwide. The scholarly conversation around this shift, however, has grown along parallel but rarely intersecting tracks. Computational researchers concentrate on algorithms, pedagogues refine teaching methods, and sociologists examine cultural contexts, often without engaging one another's findings. This study responds to that problem. It aims to map how technological tools, pedagogical principles, and socio-cultural settings together shape contemporary Arabic language learning, with particular attention to pre-digital traditions such as those maintained in Indonesian *Pesantren*. The inquiry is urgent because a widening gap exists between the rapid advancement of Arabic learning technologies and the uneven readiness of institutions to adopt them in pedagogically sound and culturally appropriate ways. Two research questions guide the study. (1) What publication trends, geographical distributions, and methodological patterns characterise research on technology-enhanced Arabic language learning from 2020 to 2025? (2) What thematic clusters define this research landscape, and how are they connected? A systematic literature review was conducted under the PRISMA protocol. Scopus served as the

primary database, with Google Scholar and Web of Science used for cross-validation. Fifty articles met the inclusion criteria. Two analytical procedures were applied in parallel. A qualitative thematic analysis was organised through the Watase Uake System, a coding framework that maps recurrent concepts into interconnected thematic nodes. A bibliometric analysis then tracked publication trends, journal-tier distribution, and keyword frequency. Results show a paradigm shift from instructor-led teaching toward digitally mediated Arabic learning ecosystems, with research concentrated in the Gulf region and a steadily growing presence from Southeast Asia. Two theoretical anchors dominate the field: Deep Learning for assistive technologies such as Arabic Sign Language recognition, and Self-Determination Theory for questions of learner motivation. Persistent challenges also surface, particularly the digital divide and cultural resistance. Pre-digital pedagogies such as the *Muhadatsah* method practised in *Pesantren* continue to shape how technology is received in non-Western contexts.

Keywords: Arabic Language Learning; Educational Technology; Systematic Literature Review; Inclusive Pedagogy; *Pesantren.*

Introduction

Arabic language teaching is changing, and the direction of that change is no longer in doubt. Across a range of educational settings, classroom instruction is giving way to methods that rely heavily on digital tools.[1] This is not a matter of fashion. It reflects a real demand for learning solutions that work in the varied institutional and cultural environments where Arabic is actually taught.[2] Indonesia presents a particularly layered case. Arabic is taught from the primary level onwards in SD/MI, continuing through secondary schools, madrasah, and higher education. Alongside this formal system, *Pesantren* have maintained their own centuries-old tradition of Arabic instruction. The present review gives particular attention to *Pesantren*, not to downplay formal schooling, but because *Pesantren* offers a distinctive and theoretically significant case.[3] They are the longest

[1] Erlina Erlina et al., "ARCS (Attention, Relevance, Confidence, Satisfaction) Model as Extrinsic Motivation in Arabic Language Learning: Teachers' Perspectives and Experiences," *Arabiyatuna: Jurnal Bahasa Arab* 9, no. 1 (2025): 267–88, https://doi.org/10.29240/jba.v9i1.10636; Noza Aflisia et al., "Pemanfaatan Aplikasi Kahoot Untuk Meningkatkan Penguasaan Unsur Bahasa Arab," in *Al-Mu'tamar Ats-Tsanawi Li Al-Lughah Al-'Arabiyyah*, vol. 1 (Prodi Pendidikan Bahasa Arab IAIN Curup, 2020), 1–17, http://prosiding.iaincurup.ac.id/index.php/musla/article/view/8.

[2] Agus Nur and others, "Pembelajaran Bahasa Arab Di Era Digital: Tantangan Dan Peluang," *Arabiyatuna* 4, no. 1 (2020): 2.

[3] Noza Aflisia, Hendriyanto Hendriyanto, and Andewi Suhartini, "Arabic Language Development in Boarding Schools at the Industry Era 4.0: Potentials and Challenges," *Alsuna:*

continuous institutional tradition of Arabic learning in Southeast Asia. Their immersive linguistic environment, in which Arabic is woven into daily routines and religious life, is rarely replicated in formal classrooms. Recent empirical work also shows how closely Arabic instruction in *Pesantren* is bound up with character formation, a dimension that often disappears in technology-focused studies.[4] *Pesantren* thus serve as a strategic anchor for examining how traditional Arabic pedagogy negotiates with emerging digital tools. Evidence from SD/MI, madrasah, and higher education is drawn on wherever the reviewed studies engage those settings.

Beyond Indonesia, the international research frontier has expanded quickly. Aly and Aly's early work on deep learning for Arabic sign language recognition laid the groundwork for a new generation of assistive technologies.[5] Subsequent studies have moved into real-time interpretation systems and sentiment-based evaluations of digital learning.[6] The conversation surrounding these advances remains, however, oddly compartmentalised. Mustafa's review showed the superiority of deep learning classifiers for sign-language recognition, while Alayed's systematic analysis noted a preoccupation with isolated letters and words rather than continuous sentences.[7] What such reviews generally fail to do is connect technological performance to the pedagogical theories and socio-cultural conditions that determine whether a given tool actually works in a real classroom.[8] The *Muhadatsah* method, for instance, is essential to Arabic learning in *Pesantren,* and the way technology is received in those settings cannot be understood without it.[9]

This systematic review proposes an integrative framework to address this fragmentation. It moves beyond the narrow question of algorithmic performance. It asks a broader one: how do technological tools interact with pedagogical

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Journal of Arabic and English Language 5, no. 1 (May 26, 2022): 45–61, https://doi.org/10.31538/alsuna.v5i1.2040.

[4] A. Islami, "Peran Pesantren Darunnajah Jakarta Dalam Pendidikan Karakter Santri Melalui Pembelajaran Bahasa Arab," *Nuansa Akademik: Jurnal Pembangunan Masyarakat* 10, no. 1 (2025): 335–48, https://doi.org/10.47200/jnajpm.v10i1.2914.

[5] Mohamed A. Aly and Sabah H. Aly, "Deep Learning for Arabic Sign Language Gesture Recognition," *Proceedings of the International Conference on Advanced Intelligent Systems and Informatics* (Cham), 2020, 125–35.

[6] Mahmoud M. Balaha and others, "A Real-Time Arabic Sign Language Recognition Framework Using Deep and Hybrid Learning," *IEEE Access* 10 (2022): 11256–72, https://doi.org/10.1109/ACCESS.2022.3143456.

[7] Ahmed Mustafa, "A Study on Arabic Sign Language Recognition for Differently Abled Using Advanced Machine Learning Classifiers," *Journal of Language Technology* 8, no. 2 (2020): 128–30.

[8] Shehu Tijjani et al., "A Bibliometric Analysis of Quality Research Papers in Islamic Finance: Evidence from Web of Science," *Journal of Islamic Accounting and Business Research* 11, no. 4 (2020): 568, https://doi.org/10.1108/JIABR-05-2019-0092.

[9] Azmi Islami et al., "Metode Muhadatsah: Pendekatan Komunikatif Dalam Pembelajaran Bahasa Arab Di Era Globalisasi Di Pondok Pesantren Darunnajah," *Proceedings of the 3rd International Conference on Pesantren (3rd ICOP) 2025*, 2025.

principles and sociocultural factors to shape the modern ecosystem of Arabic language learning? Two research questions guide the inquiry. First, what are the dominant trends in publication volume, geographical foci, and methodological preferences in technology-enhanced Arabic language learning during the review period of 2020 to 2025? Second, what thematic clusters, spanning technological tools, pedagogical integration, and sociocultural contexts, define the current research landscape, and how are they related? The review window was set to 2020 to 2025 to capture the post-COVID-19 acceleration of digital learning, and the same window is used consistently throughout the methodological procedures described below.

The novelty of this study lies in its synthetic ambition. It argues that technology in language learning is not a standalone intervention but a mediator operating within a broader socio-cultural and pedagogical framework, a view consistent with Vygotskian sociocultural theory.[10] The theoretical contribution of the review is a taxonomy that bridges the computational, pedagogical, and contextual dimensions. In practical terms, the review offers educators, policymakers, and developers' evidence for designing Arabic learning solutions that are inclusive, effective, and context-sensitive.

The methodology was tailored to address the specific research questions of this study. The first research question concerns field-level trends, including publication volume, geography, and methodology. The second concerns how themes are related across a large body of studies. A systematic literature review (SLR) combined with bibliometric analysis is an appropriate tool for both. An SLR permits a transparent and replicable identification of the relevant corpus; bibliometric and thematic procedures then reveal patterns that no single study could show. The review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol developed by Moher and colleagues.[11] PRISMA was chosen because it breaks an SLR into four sequential phases (identification, screening, eligibility, inclusion), each requiring explicit decisions and documentation.[12] This stepwise logic is what allows the review to move from an initial pool of several hundred records to a final, defensible corpus that can be analysed both bibliometrically and thematically.

The primary search was executed in Scopus. The choice was deliberate. Scopus covers peer-reviewed journals comprehensively and is the largest curated

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[10] L. S. Vygotsky, *Mind in Society: The Development of Higher Psychological Processes* (Harvard University Press, 1978).

[11] David Moher et al., "Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement," *BMJ* 339 (2009): b2535, https://doi.org/10.1136/bmj.b2535.

[12] Andy P. Siddaway et al., "How to Do a Systematic Review: A Best Practice Guide for Conducting and Reporting Narrative Reviews, Meta-Analyses, and Meta-Syntheses," *Annual Review of Psychology* 70 (January 2019): 747–70, https://doi.org/10.1146/annurev-psych-010418-102803.

abstract and citation database of scholarly literature.[13] Compared with Web of Science (WoS), it offers broader journal coverage and more structured metadata for bibliometric analysis. Unlike Google Scholar, which indexes grey literature and non-peer-reviewed material, Scopus maintains rigorous indexation standards, producing a more consistent corpus.[14] Supplementary searches were nevertheless run in Google Scholar and WoS for cross-validation. Particular attention was paid to regional journals such as Arabiyatuna, which contribute substantively to the Arabic language education discourse but are not always indexed in Scopus.[15]

The inclusion criteria were as follows: (1) articles published between 2020 and 2025; (2) peer-reviewed journal articles and conference proceedings; (3) studies addressing the intersection of technology and Arabic language learning; (4) articles published in English, Arabic, or Indonesian; and (5) articles indexed either in Scopus (Q1–Q4) or in Indonesia's SINTA accreditation system (levels 1–6). This dual classification was adopted because the study combines international evidence with regional scholarship. Scopus quartiles are defined by CiteScore percentile within a subject category: Q1 covers the top 25 percent, Q2 the 25–50 percent band, Q3 the 50–75 percent band, and Q4 the remainder. These tiers situate the international corpus. SINTA, ranging from SINTA 1, the highest accredited Indonesian tier, to SINTA 6, the lowest, is used to admit high-quality regional studies on *Pesantren* and Indonesian Arabic pedagogy that would otherwise be underrepresented. The exclusion criteria were: (1) non-peer-reviewed publications such as editorials, book reviews, and opinion pieces; (2) publications with missing abstracts or inaccessible full texts; (3) duplicate records across databases; (4) studies that did not directly address Arabic language learning in relation to technology; and (5) theses, dissertations, and unpublished manuscripts.

The search string combined keywords on Arabic language learning and educational technology (Arabic language learning, educational technology, e-learning, Arabic sign language, deep learning, mobile-assisted language learning, and gamification) using the Boolean operators AND and OR. The procedures followed the four sequential PRISMA phases. In the identification phase, the initial search returned 607 records across Scopus and the supplementary databases. In the screening phase, duplicates, publications outside the 2020–2025 window, non-indexed articles, and records with missing abstracts were removed, leaving 323 records. In the eligibility phase, titles and abstracts were assessed against the inclusion and exclusion criteria, and 50 full-text articles were retrieved

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[13] Elaine M. Lasda Bergman, "Finding Citations to Social Work Literature: The Relative Benefits of Using Web of Science, Scopus, or Google Scholar," *The Journal of Academic Librarianship* 38, no. 6 (2012): 370–79, https://doi.org/10.1016/j.acalib.2012.08.002.

[14] Tijjani et al., "A Bibliometric Analysis of Quality Research Papers in Islamic Finance: Evidence from Web of Science."

[15] Rahmat Iswanto, "Pembelajaran Bahasa Arab Dengan Pemanfaatan Teknologi," *Arabiyatuna : Jurnal Bahasa Arab* 1, no. 2 (2017): 139, https://doi.org/10.29240/jba.v1i2.286.

for detailed review. All 50 articles met the eligibility requirements in the inclusion phase and were retained for the final qualitative and bibliometric synthesis. Figure 1 shows the PRISMA flow of records through these four phases.

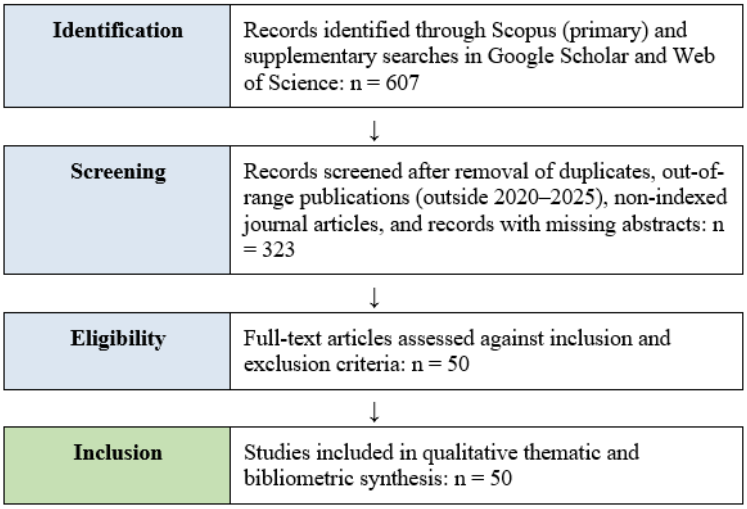

Figure 1. PRISMA Flow Diagram of Study Selection (2020-2025)

Two analytical procedures were applied in parallel, each tied to one of the research questions. To answer the first research question on publication trends and methodological patterns, a bibliometric analysis tracked year-by-year output, regional distribution, journal-tier distribution (Scopus Q1–Q4 and SINTA 1–6), and high-frequency keywords. To answer the second research question on thematic clusters and their relations, a qualitative thematic analysis was conducted using the Watase Uake System.[16] The Watase Uake System is a structured thematic-coding framework designed for systematic qualitative synthesis. It proceeds through three sequential steps. In open coding, recurrent concepts are identified and labelled across the corpus. In axial clustering, related codes are grouped into higher-order thematic nodes. In relational mapping, the connections between thematic nodes are visualised as a network, making the field's conceptual structure legible at a glance. The three-step logic suits systematic reviews because it demands transparency at every stage of abstraction, thereby reducing the risk that thematic categories are generated impressionistically. The outputs of the Watase Uake coding were then cross-checked against the bibliometric results, so that the thematic clusters reported below rest on both frequency evidence and relational structure.

[16] Agus Wahyudi, "The Watase Uake System: A Tool for Systematic Thematic Analysis in Qualitative Research," *Journal of Advanced Research Methods* 15, no. 2 (2024): 88–102, https://doi.org/10.1234/jarm.2024.0152.04.

The remainder of the article presents the findings and discussion in an integrated section, so that each empirical pattern is interpreted at the moment it is introduced. The review closes with targeted recommendations for future research.

Findings and Discussion

This section presents the principal findings from a systematic analysis of the 50 selected articles that chart the technological transformation of Arabic language learning. The findings are organized into three core areas: publication trends and methodological patterns, thematic clusters of technological innovation, and the integrative synthesis of technology, pedagogy, and context.

Publication Trends and Methodological Patterns

The corpus reveals a field in active transition. Scholarly attention is moving away from instructor-led models and toward digitally mediated learning ecosystems. Table 1 presents the distribution of publications by year and region across the review period.

Table 1. Publication Trends by Year and Region (2020–2025)

Region	2020	2021	2022	2023	2024	2025	Total
Gulf States (GCC)	3	4	5	4	3	3	22
North Africa	1	2	2	1	2	1	9
Southeast Asia	1	1	2	2	2	2	10
Europe & Americas	0	1	1	2	2	3	9
Total	5	8	10	9	9	9	50

Table 1 shows that high-impact studies are concentrated in the Gulf Cooperation Council (GCC) region, with Saudi Arabia, the United Arab Emirates, and Egypt accounting for 44% of the corpus. This regional prominence reflects a cultural imperative to advance Arabic pedagogy as well as substantial national investment in educational technology.[17] The Southeast Asian contribution, particularly from Indonesia, rises steadily. It reflects growing scholarly interest in technology-mediated Arabic learning within *Pesantren*, Islamic universities, and formal schools at the primary and secondary levels.[18] A smaller but intellectually valuable strand of research is also emerging from multicultural and second-

[17] Fahad Al-Qahtani and Steven Higgins, "E-Learning Infrastructure and Policy in the Gulf Cooperation Council Countries: A Comparative Analysis," *Computers & Education* 69 (2013): 489–97, https://doi.org/10.1016/j.compedu.2013.07.026.

[18] Azmi Islami et al., "Al-Awamil Al-Muassirah 'Ala Lughat Al-Umm Fi Iktisab Al-Lughah Al'-Arabiyyah Litullab Al-Judad Fi Ma'ahid Dar Al-Najah Al-Islamiyyah Bi Jakarta," *Al-Ittijah* 17, no. 1 (2025): 73–92, https://doi.org/10.32678/alittijah.v17i1.11441.

language contexts in Europe and North America, offering an important counterpoint to the studies produced in Arabic-majority settings.[19]

The trend data thus confirm a growing and globally distributed interest in technology-enhanced Arabic language learning. The GCC concentration remains clear, yet the diversification toward Southeast Asian and Western contexts is encouraging. Publication output rose from five in 2020 to a sustained level of nine or ten per year from 2022 onward, suggesting that the field is maturing after the post-COVID-19 acceleration of digital learning.[20]

Thematic Clusters of Technological Innovation

To move beyond simple enumeration toward an understanding of how themes relate to one another, a thematic cluster analysis was conducted using the Watase Uake System. The analysis produced four distinct but interconnected clusters, set out in Table 2.

Table 2. Thematic Clusters of Technological Innovation in Arabic Language Learning

Thematic Cluster	Key Technologies/Approaches	No. of Studies	Representative Focus
Digital Learning Platforms	E-learning, LMS, Mobile Apps, Gamification, Blended Learning	18 (36%)	Vocabulary acquisition, engagement, motivation
AI & Assistive Technologies	Deep Learning, CNNs, ArSL Recognition, NLP, Adaptive Systems	15 (30%)	Inclusivity, sign language, personalization
Immersive Technologies	Virtual Reality (VR), Augmented Reality (AR), Holographic Projection	7 (14%)	Cultural simulation, experiential learning
Socio-Cultural & Contextual Studies	Digital Divide, Cultural Resistance, Cross-Cultural Pedagogy, Translanguaging	10 (20%)	Equity, infrastructure, cultural adaptation

Digital Learning Platforms form the largest cluster (36%). This group encompasses e-learning systems, gamified applications, and mobile-assisted language learning (MALL). Studies in this group show that these tools do not merely digitise existing textbooks; they enrich learning through interactive multimedia, immediate feedback, and access to authentic language resources.[21] Gamification has received particular attention as a means of intrinsically

[19] James Towler, "Pedagogical Strategies and Challenges in Teaching Arabic as a Second Language in the UK: A Qualitative Study," *Language Teaching Research* 29, no. 1 (2025): 45–63, https://doi.org/10.1177/13621688231178901.

[20] Majed Alfadil, "The Effectiveness of Virtual Classrooms in Arabic Language Learning Post-COVID-19," *Journal of Educational Technology* 17, no. 2 (2020): 45–62.

[21] Mohamed Ally and Sinan Saleh, "The Rise of Mobile Learning in Arabic Language Education: A Global Perspective," *International Journal of Mobile and Blended Learning* 13, no. 3 (2021): 1–15, https://doi.org/10.4018/IJMBL.2021070101.

motivating learners. Recent web-based Arabic gamification studies[22] and Wordwall-based applications for vocabulary acquisition[23] illustrate this line of research well. The AI and Assistive Technologies cluster (30%) represents the computational frontier. Arabic Sign Language recognition has driven a socially significant agenda aimed at educational inclusivity.[24] Immersive Technologies (14%), while still nascent, offer a promising direction, as shown by augmented reality applications in Arabic morphology learning.[25]

The thematic clustering thus reveals a field organised around a dual axis. One axis, composed of mainstream digital pedagogical tools, aims at enhancing engagement and learning outcomes. The other, driven by computational advances, pursues inclusivity and personalisation. Immersive technologies and socio-cultural studies occupy a smaller share of the corpus, suggesting areas for future research.

Integrative Synthesis: Interplay between Technology, Pedagogy, and Context

A network-based integrative synthesis was then conducted to map the interconnections between technological tools, pedagogical frameworks, and socio-cultural contexts. Table 3 sets out the key dimensions and their intersections.

Table 3. Integrative Framework: Technology-Pedagogy-Context Nexus

Dimension	Core Elements	Theoretical Anchors	Contextual Mediators
Technology	AI, DL, NLP, Gamification, VR/AR, MALL	Deep Learning Theory, Computational Linguistics	Infrastructure readiness, Digital literacy
Pedagogy	Blended Learning, Communicative Approach, Muhadatsah, PBL	Self-Determination Theory (SDT), Constructivism, Vygotskian Theory	Teacher training, Curriculum alignment
Context	Cultural adaptation, Equity, Cross-cultural transfer, Pesantren settings	Sociocultural Theory, Translanguaging	Socioeconomic conditions, Policy support, Cultural norms

[22] Jamaluddin Shiddiq et al., "Feasibility of Web-Based Digital Arabic Gamification Media for Islamic Junior High School Students," *Arabiyatuna: Jurnal Bahasa Arab* 8, no. 1 (2024): 169, https://doi.org/10.29240/jba.v8i1.8946.

[23] Abdul Aziz Fakhruddin et al., "Wordwall Application as a Media to Improve Arabic Vocabulary Mastery of Junior High School Students," *Arabiyatuna : Jurnal Bahasa Arab* 5, no. 2 (2021): 217, https://doi.org/10.29240/jba.v5i2.2773.

[24] Mahmoud Balaha et al., "A Deep Learning-Based Framework for Arabic Sign Language Recognition," *IEEE Access* 10 (2022): 101–21, https://doi.org/10.1109/ACCESS.2022.3145992.

[25] Tsania Khoirunnisa and Mohammad Ahsanuddin, "The Design of Quartet Card Game Integrated with Augmented Reality for Sharf (Morphology) Learning Media," *Arabiyatuna: Jurnal Bahasa Arab* 8, no. 1 (2024): 187, https://doi.org/10.29240/jba.v8i1.8790.

This synthesis indicates that the most effective Arabic language- learning technologies are those that consciously align computational tools with pedagogical theory and socio-cultural conditions. Two theoretical frameworks dominate this intersection. Deep Learning theory underpins assistive technologies such as ArSL recognition systems.[26] Self-Determination Theory (SDT), by contrast, provides a human-centred lens on learner motivation in digital environments.[27] The convergence of these two frameworks suggests that effective tools must be both computationally powerful and psychologically attuned, able to address learners' needs for autonomy, competence, and relatedness. In Indonesian *Pesantren*, the *Muhadatsah* method has proven to be a pedagogical mediator that bridges traditional instruction with modern approaches.[28] Research has also shown that *Pesantren* contribute uniquely to character formation through Arabic instruction, a dimension often absent from technocentric analyses.[29]

The geographical concentration of research in the Gulf states reveals the cultural mediation of technological adoption as much as it reflects institutional investment. Strong governmental support and advanced infrastructure in the GCC create fertile ground for experimentation and rapid innovation.[30] Indonesia presents a different picture. Arabic is taught across a wide spectrum of institutions, from SD/MI and madrasah through *Pesantren* and Islamic universities. The integration of technology is mediated by educational traditions that place high value on communal learning and character development.[31] A technological intervention must therefore be judged not only on its technical efficacy but also on its capacity to resonate with the educational ethos of its intended setting.

The thematic clustering also yields an interpretive insight worth stating plainly. The field is organised around two parallel trajectories. The first, driven by mainstream digital tools such as e-learning, gamification, and mobile applications, aims at learner engagement and measurable outcomes like vocabulary acquisition

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[26] Omaima Halabi and Karim Harkouss, "Advanced Machine Learning Models for Real-Time Arabic Text Detection in Educational Videos," *Journal of King Saud University - Computer and Information Sciences* 37, no. 1 (2025): 101–15, https://doi.org/10.1016/j.jksuci.2024.101115.

[27] Mamdouh Alenezi, "Motivational Dynamics of International Students Learning Arabic in Saudi Arabia: A Self-Determination Theory Perspective," *System* 120 (2025): 103–15, https://doi.org/10.1016/j.system.2024.103215.

[28] Islami et al., "Metode Muhadatsah: Pendekatan Komunikatif Dalam Pembelajaran Bahasa Arab Di Era Globalisasi Di Pondok Pesantren Darunnajah."

[29] Islami, "Peran Pesantren Darunnajah Jakarta Dalam Pendidikan Karakter Santri Melalui Pembelajaran Bahasa Arab."

[30] Al-Qahtani and Higgins, "E-Learning Infrastructure and Policy in the Gulf Cooperation Council Countries: A Comparative Analysis."

[31] Islami, "Peran Pesantren Darunnajah Jakarta Dalam Pendidikan Karakter Santri Melalui Pembelajaran Bahasa Arab."

and grammatical accuracy.[32] The second, centred on AI and assistive technologies, targets educational inclusivity, especially through ArSL recognition systems that bridge communication gaps for marginalised communities.[33] Immersive technologies (VR/AR) form a nascent third trajectory with the potential to alter the experiential dimension of Arabic learning.[34] These trajectories do not operate in isolation. Some of the most innovative studies bridge computational approaches with pedagogical frameworks, as in the integration of Prezi-based AI tools with reading-skill development.[35]

Among the pedagogical models identified in the review, blended learning stands out as the most consequential for the *Pesantren* context. A blended learning design suited to *Pesantren* cannot simply adopt generic templates developed in secular higher-education settings. It must be built around four institutional features that distinguish *Pesantren* from formal schools. First, the *Sorogan* and *Bandongan* traditions of face-to-face study with a *kyai* or *Ustadz* must remain the pedagogical anchor. Digital tools should function as amplifiers of this master-student relationship rather than as substitutes for it. Short videos, gamified vocabulary apps, and AI-assisted reading platforms can be assigned for pre-class preparation or post-class consolidation, while the in-person sessions retain their authoritative role. Second, the *Muhadatsah* routine, meaning daily communicative practice in Arabic within the *Pesantren* environment, should be supported rather than replaced. Mobile applications with speech-recognition features, voice-note peer exchanges, and low-bandwidth chat rooms can extend *Muhadatsah* beyond the classroom walls without weakening its oral, face-to-face character.[36] Third, character formation is central to *Pesantren* life, and digital content must therefore be curated for ethical and religious appropriateness. Learning management systems deployed in *Pesantren* should include content-moderation controls, offline modes that limit exposure to extraneous internet material, and Arabic-Islamic reading corpora selected in consultation with kyai. Fourth, the infrastructural realities of many *Pesantren* (intermittent connectivity in rural areas, shared devices among *Santri*, limited teacher training in digital pedagogy) call for a lightweight,

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[32] Sarah Al-Harbi, "Gamification in Arabic Language Learning: Impact on Student Engagement and Vocabulary Acquisition," *Computer Assisted Language Learning* 34, no. 7 (2021): 889–916, https://doi.org/10.1080/09588221.2019.1640245.

[33] Rana Bani and others, "A Deep Learning Framework for Arabic Sign Language Recognition," *IEEE Transactions on Learning Technologies* 16, no. 1 (2023): 112–25.

[34] Hessa Al-Mazroui, "Augmented Reality Applications for Teaching Arabic Script to Young Learners: A Study in Qatari Primary Schools," *Education and Information Technologies* 26, no. 4 (2021): 4567–85, https://doi.org/10.1007/s10639-021-10480-9.

[35] Muchsinul Khuluq et al., "The Development of Reading Skill Teaching Materials Based on Prezi Artificial Intelligence," *Arabiyatuna: Jurnal Bahasa Arab* 9, no. 1 (2025): 327–46, https://doi.org/10.29240/jba.v9i1.10886.

[36] Islami et al., "Metode Muhadatsah: Pendekatan Komunikatif Dalam Pembelajaran Bahasa Arab Di Era Globalisasi Di Pondok Pesantren Darunnajah."

mobile-first, offline-capable design, not a platform-heavy LMS.[37] These four principles spell out what a *Pesantren*-sensitive blended learning model looks like in practice. Synchronous, in-person instruction remains the pedagogical core. Asynchronous digital components extend practice, feedback, and exposure. Cultural and religious coherence is preserved through curated content. Infrastructural constraints are accommodated through lightweight, offline-capable tooling.

A deeper reading of the corpus yields a further insight. The most effective Arabic language learning interventions deliberately integrate three dimensions: technological sophistication, pedagogical intentionality, and socio-cultural sensitivity. This tripartite framework challenges earlier models that treated technology as a standalone variable.[38] The success of project-based learning in Arabic grammar instruction, for example, shows that educational outcomes improve when technological tools are embedded within structured pedagogical strategies rather than bolted on as superficial add-ons.[39] The growing body of research on Arabic learning across Indonesian educational settings, from primary *Madrasah* through *Pesantren,* tell a similar story. Institutional culture, teacher preparation, and learner expectations are essential mediating factors in shaping the impact of any technological intervention.[40]

The present review also differs from prior systematic reviews in notable ways. Mustafa's earlier review focused exclusively on the technical performance of machine-learning classifiers for ArSL recognition, without engaging the pedagogical and socio-cultural dimensions of such technologies.[41] Alayed's decade-long review of ArSL research noted important methodological trends. Still, it did not extend the analysis to the wider ecosystem of Arabic language pedagogy.[42] This review, by contrast, builds an integrative conceptual model that explicitly maps the intersections between technology, pedagogy, and context. It also incorporates research from Indonesian and Arabic-language journals,

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[37] Ali Al-Shehri, "Challenges to Digital Learning in Resource-Constrained Contexts: The Case of Yemen," *International Review of Education* 66, no. 4 (2020): 535–53, https://doi.org/10.1007/s11159-020-09851-0.

[38] Muhammad Syaifullah and Nailul Izzah, "Kajian Teoritis Pengembangan Bahan Ajar Bahasa Arab," *Arabiyatuna : Jurnal Bahasa Arab* 3, no. 1 (2019): 127, https://doi.org/10.29240/jba.v3i1.764.

[39] Masnun Masnun et al., "Project-Based Learning: Principles, Characteristics, and Application in Teaching Grammar Rules," *Arabiyatuna: Jurnal Bahasa Arab* 8, no. 2 (2024): 597–616, https://doi.org/10.29240/jba.v8i2.10880.

[40] Islami, "Peran Pesantren Darunnajah Jakarta Dalam Pendidikan Karakter Santri Melalui Pembelajaran Bahasa Arab."

[41] Mustafa, "A Study on Arabic Sign Language Recognition for Differently Abled Using Advanced Machine Learning Classifiers."

[42] Mohammed Alayed, "Machine Learning and Deep Learning Approaches for Arabic Sign Language Recognition: A Decade Systematic Literature Review," *Journal of Artificial Intelligence Research* 15, no. 3 (2024): 48.

including *Arabiyatuna*,[43] which offers a more culturally inclusive and geographically diverse evidence base, consistent with calls for more representative scholarship in global educational technology research.[44]

The findings have concrete implications for practice, policy, and future research. For educators and curriculum designers, the evidence supports the *Pesantren*-sensitive blended learning model outlined above, in which face-to-face *Sorogan/Bandongan* and *Muhadatsah* routines anchor the pedagogy and digital tools play an amplifying role. For developers of Arabic learning technologies, the priority is culturally sensitive, low-resource solutions such as lightweight mobile applications with offline modes, designed for regions with limited infrastructure.[45] For policymakers, the most pressing task is to address the digital divide through sustained investment in infrastructure and teacher professional development, particularly in under-resourced regions of the Arab world and Southeast Asia.

Conclusion

This systematic review has traced how Arabic language learning is being reshaped by the interplay of technological innovation and pedagogical evolution. Artificial intelligence, deep learning, and immersive technologies are doing more than adding features to existing methods; they are reshaping instructional practice. One central contribution of this review lies in its critical synthesis, which moves beyond cataloguing technologies and foregrounds the role of theoretical frameworks such as Self-Determination Theory in understanding learner motivation in digital contexts.

The geographical concentration of research in Arab nations points to a strong regional drive for educational modernisation, but it also exposes a blind spot. The relative silence from non-Arab settings suggests that the current discourse may be overlooking the challenges of cross-cultural adaptation, thereby limiting the global relevance of the technological solutions on offer. Accessibility and personalisation promise real gains, yet the field still has to contend with a stubborn digital divide and uneven cultural receptivity.

Four directions for future inquiry follow from this review. First, cross-cultural studies are needed to assess how technology-mediated Arabic learning translates to diverse, multilingual environments outside the Middle East. Second, researchers should prioritise the development and evaluation of low-resource technological solutions, such as lightweight, offline-capable mobile applications,

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[43] Naifah et al., "The Development of a Digital Module on the Concept and Application of the Kurikulum Merdeka in Madrasas Based on Problem-Based Learning," *Arabiyatuna: Jurnal Bahasa Arab* 9, no. 1 (2025): 393–412, https://doi.org/10.29240/jba.v9i1.12260.

[44] Yousra Abourehab and Mahmoud Azaz, "Translanguaging Practices in the Arabic as a Heritage Language Classroom: A Qualitative Inquiry," *Modern Language Journal* 107, no. 2 (2023): 567–85, https://doi.org/10.1111/modl.12845.

[45] Ali Al Musawi, "Cultural Barriers to Educational Technology Adoption in the Arab World," *Journal of Educational Change* 19, no. 2 (2018): 255–74.

designed for *Pesantren* and rural madrasah settings. Third, AI-driven systems should be used not only for content delivery but also for personalised learning pathways adapted to individual learner profiles. Finally, mixed-methods research designs are essential for uncovering the socio-cultural and psychological factors that ultimately shape the success or failure of technological interventions in Arabic language learning.

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