



Technology Online in Arabic Learning

Volume 1, Issue 1, June 2026

e_ISSN: XXXX-XXXX

<https://journal.nimsyapublisher.id/index.php/toal>

Adaptive Arabic Online Learning Strategy Using Mobile Technology and Social Media for Personalization

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Article Info

Article history:

Received: May 10, 2026

Revised: June 19, 2026

Accepted: June 30, 2026

Keywords:

Adaptive Strategy,
Arabic Language Online,
Mobile Technology,
Personalized Learning,
Social Media

Abstract

The growing diversity of Arabic language learners necessitates adaptive strategies that accommodate individual differences in proficiency, pace, and motivation. Traditional one-size-fits-all online approaches often fail to address these varied needs. This study aims to develop and test an adaptive online Arabic learning strategy that integrates mobile technology and social media to deliver personalized learning experiences. Employing a mixed-method sequential explanatory design, the research involved 150 Arabic learners from five Indonesian universities. Participants were divided into an experimental group (n=75) receiving an adaptive mobile-social media integrated strategy, and a control group (n=75) receiving non-adaptive online instruction. The intervention featured a personalized mobile app with AI-driven content adaptation and a private social media community for collaborative learning. The experimental group significantly outperformed the control group in overall Arabic competency (mean posttest: 87.3 vs. 59.6; $t = 14.876$, $p < 0.001$, Cohen's $d = 2.01$). Additionally, the adaptive group reported higher motivation (92% vs. 61%), greater perceived personalization (88% vs. 34%), and a stronger sense of learning community (84% vs. 42%). The study concludes that adaptive strategies leveraging mobile technology and social media effectively personalize Arabic online learning, significantly enhancing both competency and engagement, thereby overcoming the limitations of non-adaptive methods.

To cite this article: Selim, H. H. H., Widayanti, R., & Faedurrohman. (2026). Adaptive Arabic Online Learning Strategy Using Mobile Technology and Social Media for Personalization. *Technology Online in Arabic Learning*, 1(1), 34-50. <https://journal.nimsyapublisher.id/index.php/toal/article/view/29>

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INTRODUCTION

The population of Arabic language learners today exhibits an increasingly complex and multidimensional diversity that poses profound challenges to traditional instructional approaches (Beatty, 2024). This diversity extends far beyond mere age differences ranging from adolescent students to working professionals and encompasses significant variations in initial proficiency levels, learning objectives, cultural and educational backgrounds, cognitive learning styles, and access to technological resources (Arifin, 2025). At one extreme, there are absolute beginners who have never been exposed to the Arabic script at all, confronting the fundamental challenges of recognizing unfamiliar letter shapes, associating graphemes with phonemes, and adapting to a right-to-left orthographic system that directly contradicts the left-to-right writing conventions of the Latin alphabet with which they are familiar. At the opposite extreme, there are learners who come from traditional Islamic educational backgrounds, such as pesantren or madrasah institutions, who possess passive familiarity with the Arabic script through Quranic reading practice but remain severely limited in their active communicative abilities both spoken and

written in Modern Standard Arabic ([Wargadinata & Maimunah, 2024](#)). Even among ostensibly more homogeneous populations, such as university students enrolled in Arabic language programs, striking differences emerge in learning pace, retention capacity, grammatical aptitude (particularly in mastering the intricate rules of *nahwu* and *sharf*), and preferred learning modalities some learners respond more readily to audiovisual input, while others favor text-based instruction or direct social interaction ([Fauzi & Nuha, 2024](#)). This heterogeneity fundamentally undermines the effectiveness of traditional one size fits all instructional approaches, which implicitly assume that all learners progress through identical content at an identical pace. Despite the clear inadequacy of such uniform approaches, they continue to dominate most online Arabic courses today, resulting in a predictable pattern of negative outcomes: beginners become overwhelmed and frustrated when materials advance too quickly, while advanced learners become bored and disengaged when content fails to challenge them ([Liu & Zhang, 2025](#); [Dhieib, 2025](#)). This phenomenon creates a widening achievement gap and contributes to alarmingly high dropout rates, which represent a serious and persistent problem in online Arabic language education.

The inadequacy of non-adaptive approaches becomes even more acute when considering the unique and formidable linguistic characteristics of Arabic itself ([Firdaus & Hasanah, 2025](#); [Zhao & Wang, 2024](#)). First, there exists a significant diglossic gap between Modern Standard Arabic (*Fusha*), which is used in formal writing, news media, and literature, and the numerous regional dialects (*amiyah*) employed in everyday conversation across the twenty two Arab countries dialects that are often mutually unintelligible across different regions. Second, the right-to-left orthographic system, entirely foreign to most non-Arab learners, demands not only the development of new reading habits but also significant motor adaptation for writing. Third, Arabic morphology is extraordinarily complex and highly inflectional, built upon triliteral root systems that can be transformed through thousands of derivational and inflectional patterns to generate vastly different meanings, requiring systematic and graduated scaffolding to avoid overloading the learner's working memory. Fourth, there are substantial phonological distinctions such as the pharyngeal and uvular consonants like *'ain* (ع), *ghain* (غ), and *qaf* (ق) that do not exist in many learners' first languages, necessitating intensive and personalized listening and articulation practice. Non-adaptive instructional approaches are structurally incapable of addressing these individualized linguistic challenges effectively, precisely because they treat all learners as if they shared identical starting points, identical learning trajectories, and identical difficulties.

It is against this backdrop of increasing learner diversity and the manifest limitations of uniform instruction that the present study is situated. The primary objective of this investigation is to develop and empirically test an adaptive online Arabic learning strategy that holistically integrates mobile technology and social media to deliver truly personalized learning experiences tailored to each individual learner's unique profile ([Egbert & Roe, 2025](#)). More specifically, this study aims to: (a) design and implement a mobile application for Arabic learning equipped with an artificial intelligence-driven adaptation engine capable of dynamically adjusting content difficulty levels, feedback types, and presentation pacing based on real time learner performance data; (b) integrate a private social media community that functions as a structured space for collaboration and social interaction, where learners are grouped according to compatible proficiency levels and shared interests; (c) measure the effectiveness of this integrated adaptive strategy compared to non-adaptive online instruction in terms of overall Arabic competency gains; and (d) evaluate the impact of this strategy on learner motivation, perceived personalization, and sense of learning community.

The significance of this research cannot be overstated, as it addresses several urgent and interrelated needs in the field of Arabic language education. First, this study offers a replicable and scalable model that can be adopted by educational institutions across Indonesia and the broader Islamic world, where the implementation of technology enabled adaptive approaches remains extremely limited despite the growing demand for Arabic proficiency. Second, the findings of this research are expected to inform the design of next generation online Arabic learning platforms that are more responsive to individual learner needs, thereby potentially increasing learner retention, reducing dropout rates, and ultimately producing graduates with substantially higher linguistic competence. Third, this study provides concrete guidance for Arabic educators in developing

adaptive pedagogical competencies the ability to adjust instructional strategies based on learner characteristics which is becoming an increasingly essential requirement in the digital education era. Fourth, from a policy perspective, the results of this study can serve as an evidence base for decision-makers in universities and ministries of education to allocate resources toward the development of more equitable and inclusive adaptive learning systems.

A careful examination of the relevant literature reveals both significant advances and persistent gaps that justify the present investigation. Mobile technology has emerged as a particularly promising platform for delivering adaptive and personalized learning experiences, primarily because of the ubiquity of smartphones, their inherent portability, and their always connected nature, all of which support the distributed practice essential for effective language acquisition ([Kukulska-Hulme & Shield, 2023](#)). Unlike desktop based learning, which is tied to specific locations and scheduled sessions, mobile devices are inherently personal to the learner, enabling the continuous collection of individual performance data that can drive adaptive content recommendations. Masnur ([2026](#)) demonstrated the effectiveness of a mobile application for Arabic learning, but notably, that application did not yet incorporate adaptive personalization based on learner performance it remained static and linear in its content delivery. Similarly, social media platforms represent another powerful but frequently underutilized resource for personalized Arabic learning. Beyond their primary function as communication tools, social media platforms generate rich learner data posts, comments, likes, shares, and interaction patterns that can inform adaptive strategies by revealing learner interests, language use patterns, and social connections ([Thorne & Reinhardt, 2023](#); [Asrori & Maulana, 2024](#)). More importantly, social media can foster personalized learning communities where learners interact based on shared proficiency levels, interests, or goals, thereby creating social scaffolding that complements and reinforces technological adaptation. However, the integration of social media into adaptive Arabic learning strategies remains almost entirely unexplored in the existing literature. Several previous studies have examined personalization in language learning from different angles. Liu and Zhang ([2025](#)) conducted a systematic review of AI-powered personalization in online language learning and identified adaptive content sequencing and personalized feedback as the most effective features for improving learning outcomes. Hasanah et al. ([2025](#)), Muassomah & Munir ([2025](#)) explored AI-integrated web-based strategies for Arabic learning and found that adaptive systems significantly enhance learner autonomy and engagement in the learning process. Chen and Xie ([2025](#)) performed a meta-analysis on gamification in language learning and observed that personalized game elements such as adaptive difficulty levels and tailored rewards produce substantially larger effects than non-personalized gamification. Yet, none of these studies specifically examined the combination of mobile technology and social media for personalized Arabic learning, leaving a significant gap in the literature ([Hanifah & Siraj, 2024](#)). Research on social media for language learning has yielded promising but somewhat mixed results. Thorne and Reinhardt ([2023](#)) found that social media provides authentic input and meaningful communication opportunities, but they also cautioned that unstructured social media use may lead to information overload and off-task behavior that undermines learning effectiveness. Kohnke and Moorhouse ([2022](#)) examined synchronous online learning through video conferencing and discovered that personalizing breakout room assignments based on proficiency levels significantly increased engagement and meaningful interaction among learners. For Arabic specifically, Sholihah and Fauzi ([2025](#)) found that YouTube effectively supported vocabulary learning, but only when learners were able to select content matching their personal interests and proficiency levels a finding that underscores the critical importance of personalization in social media-based learning. These findings collectively suggest that social media requires strategic structuring to fully realize its personalization potential, and that this structuring must be carefully aligned with other technological components ([Hockly, 2024](#); [Kohnke & Moorhouse, 2022](#)).

Despite these advances, several significant gaps persist in both research and practice, and it is precisely these gaps that the present study seeks to address. First, most existing adaptive language learning systems focus narrowly on cognitive adaptation such as adjusting content difficulty and targeting specific skills while largely neglecting affective and social adaptation, which encompasses motivation, learning preferences, cognitive styles, and social connection needs. This is a serious oversight, given that educational psychology research consistently demonstrates that affective and

social factors are at least as important as cognitive factors in determining language learning success ([Runtoni, 2025](#)). Second, mobile technology and social media are typically studied as separate domains in the literature, rather than as an integrated ecosystem in which mobile devices provide cognitive personalization (content, feedback, pacing) and social media provides social personalization (peer matching, community formation, collaborative interaction). This separation fails to capture the synergistic potential of combining these two powerful platforms. Third, existing adaptive systems for language learning have been developed primarily for English and other European languages, with minimal consideration of Arabic's unique linguistic features its highly inflected morphology, its diglossic structure, its right-to-left orthography, and its phonologically distinctive sound system. Fourth, there is a notable scarcity of empirical evidence comparing adaptive mobile-social media strategies against non-adaptive controls in authentic educational settings over extended periods of time; most studies remain short-term in duration and are conducted under laboratory conditions that do not adequately represent the complexities of real classroom environments ([Hasanah et al., 2025](#)). These gaps collectively underscore the urgent need for research that takes a more holistic, integrated, and contextually sensitive approach to adaptive Arabic learning.

The novelty of the present research lies precisely in its development and testing of an integrated adaptive strategy that simultaneously leverages mobile technology for personalized cognitive adaptation encompassing the dynamic adjustment of content difficulty, feedback types, and learning pacing and social media for personalized social adaptation encompassing proficiency-based peer matching, interest aligned community formation, and structured collaborative learning facilitation. Unlike previous studies that have focused on a single dimension of personalization, this research adopts a genuinely holistic approach that recognizes learners differ not only in prior knowledge but also in motivational orientations, preferred learning speeds, and social learning needs ([Runtoni, 2025](#)). The integration of mobile and social media within a single coherent adaptive strategy represents a significant advancement over the single platform approaches that currently dominate the field. Furthermore, by situating this investigation within the specific context of Arabic language education in Indonesia a country with the world's largest Muslim population and consequently enormous demand for Arabic proficiency this study addresses a context that has been largely overlooked in the international adaptive learning literature.

Based on the theoretical framework and empirical findings reviewed above, this study advances the primary hypothesis that learners receiving the adaptive mobile-social media integrated strategy will demonstrate significantly greater Arabic competency gains than learners receiving non-adaptive online instruction. More specifically, the following hypotheses are proposed: (H1) there will be a statistically significant difference in post-test Arabic competency scores between the experimental group and the control group following the intervention; (H2) learners in the experimental group will report significantly higher levels of learning motivation compared to the control group; (H3) learners in the experimental group will have significantly stronger perceptions of personalization compared to the control group; and (H4) learners in the experimental group will experience a significantly stronger sense of learning community compared to the control group. The independent variable in this study is the type of learning strategy: the adaptive mobile-social media integrated strategy (experimental group) versus non-adaptive online instruction (control group). The dependent variables include: (a) overall Arabic competency, measured through a comprehensive post-test encompassing listening, reading, writing, and speaking skills; (b) learning motivation level, measured using a validated motivation questionnaire; (c) perceived personalization, measured through a personalization perception scale; and (d) sense of learning community, measured through a learning community sense scale. Control variables include initial proficiency level (assessed via pre-test), age, gender, prior Arabic educational background, and access to technological devices.

To test these hypotheses, the study employs a sequential explanatory mixed-method design that combines quantitative and qualitative approaches in a logical sequence. The quantitative phase utilizes a quasi-experimental pretest-posttest control group design, involving 150 Arabic language learners drawn from five universities across Indonesia through purposive sampling. These learners are evenly divided into an experimental group (n=75) and a control group (n=75). The intervention provided to the experimental group consists of two integrated components: a personalized mobile

application with an AI-driven adaptation engine that dynamically adjusts content, difficulty levels, feedback, and learning pacing based on real-time learner performance, and a private social media community specifically designed to facilitate structured collaboration, discussion, and peer learning grouped by proficiency level. The control group receives non-adaptive online instruction through a conventional learning platform in which all learners receive identical materials, assignments, and schedules without any personalization of content or structured social interaction. The intervention spans a full academic semester of fourteen weeks. The qualitative phase follows the quantitative analysis, employing semi-structured interviews with twenty purposively selected learners from the experimental group, complemented by participatory observation of interactions within the social media community, to explore in depth the learners' experiences, perceptions, and challenges encountered during their engagement with the adaptive strategy. This mixed-method approach allows for both statistical generalizability and rich contextual understanding of the phenomena under investigation.

For the purposes of clarity and conceptual precision, several key terms and abbreviations used throughout this study are defined as follows. Adaptive learning strategy refers to an instructional approach that dynamically adjusts content, pacing, feedback types, and learning pathways based on individual learner performance, preferences, and characteristics as monitored in real-time through an artificial intelligence-driven system ([Hidayat & Nurhidayah, 2025](#)). Mobile technology refers to handheld computing devices including smartphones and tablets along with their software applications, which enable access to learning materials, interactive exercises, and personalized feedback anytime and anywhere, thereby supporting the principles of distance education and mobile learning. Social media refers to digital platforms that facilitate social interaction, content sharing, and collaboration among users; in the specific context of this study, it refers to a private community built on platforms such as WhatsApp Groups or dedicated discussion forums designed for structured collaborative learning purposes ([Hakim & Suryani, 2025](#)). Personalization refers to the process of tailoring the learning experience based on individual learner characteristics, encompassing cognitive dimensions (difficulty, content), affective dimensions (motivation, interest), and social dimensions (interaction, community). Arabic competency refers to the integrated ability encompassing the four language skills listening (*istima'*), speaking (*kalam*), reading (*qira'ah*), and writing (*kitabah*) as well as mastery of grammar (*nahwu*) and morphology (*sharf*), enabling the learner to communicate effectively in Arabic. Learning community refers to a group of learners who interact, share experiences, support one another, and learn collaboratively, facilitated in this study through a private social media platform with grouping based on proficiency levels and interests. AI (Artificial Intelligence) refers to computing systems that simulate human intelligence processes, including machine learning and natural language processing, which in this study are used to analyze learner performance and provide automatic adaptive content recommendations ([Godwin-Jones, 2024](#); [Levy & Hubbard, 2024](#)). MSA (Modern Standard Arabic / *Fusha*) refers to the standardized form of Arabic used in formal contexts, writing, mass media, and education, which differs significantly from the regional dialects used in everyday conversation ([Levy & Stockwell, 2023](#)). Through this comprehensive and integrated approach, the present study aims to make a meaningful contribution to both the theoretical understanding and practical implementation of adaptive personalized learning in Arabic language education, addressing the critical limitations of one size fits all approaches that have long hindered effective language acquisition for diverse learner populations.

METHOD

This study employed a mixed-method sequential explanatory design, where quantitative data (pre-post tests, questionnaires, platform analytics) were collected and analyzed first, followed by qualitative data (semi-structured interviews, focus group discussions) to explain and elaborate the quantitative findings. This design was chosen because it allows for the measurement of intervention effectiveness while also providing rich contextual understanding of why and how the adaptive strategy works or fails ([Creswell & Creswell, 2023](#)). The research was conducted over one academic semester (16 weeks) at five universities in Indonesia representing diverse geographic regions, institutional types, and learner demographics.

The research population comprised all Arabic language learners enrolled in beginner and intermediate level courses at the five participating universities. Using G*Power software to determine minimum sample size ($\alpha = 0.05$, power = 0.80, medium effect size), a target of 140 participants was established. A total of 150 learners were recruited using stratified random sampling, with strata defined by university, proficiency level (beginner or intermediate based on placement test), and prior mobile learning experience. Participants were then randomly assigned to the experimental group (n=75) receiving the adaptive mobile-social media integrated strategy or the control group (n=75) receiving non-adaptive online instruction using the same core content but without adaptive features or social media integration.

The intervention for the experimental group consisted of two integrated components. The first component was a personalized mobile application (named "ArabiAdapt") developed specifically for this study. The application incorporated: (1) adaptive content sequencing using Bayesian Knowledge Tracing algorithms that continuously estimated learner proficiency on each linguistic sub-skill, adjusting difficulty and sequencing accordingly; (2) personalized feedback generation based on error pattern analysis, providing elaborated explanations tailored to specific learner mistakes; (3) adaptive spacing of review items using Leitner system algorithms optimized for individual forgetting curves; and (4) personalized goal setting and progress visualization dashboards. The second component was a private social media community (using a dedicated WhatsApp group and a private Instagram account) structured to support personalized social learning through: (1) proficiency-based peer matching for pair and small group activities; (2) interest-based topic channels (e.g., #ArabicForTravel, #ArabicForBusiness, #QuranicArabic); (3) daily personalized challenges posted based on learner profiles; and (4) peer feedback protocols scaffolded by instructor moderation.

The control group received non-adaptive online instruction using a standard learning management system (Moodle) with the same core content and total learning time as the experimental group. Control group participants accessed: (1) linear, non-adaptive content sequenced identically for all learners; (2) generic feedback that did not adapt to individual error patterns; (3) fixed review schedules not optimized for individual forgetting curves; (4) standard discussion forums without proficiency-based matching or personalization. The control group had access to WhatsApp for course announcements but did not receive structured social media learning activities. All other features (total content, assessment frequency, instructor availability) were held constant between groups to isolate the effect of adaptive personalization and structured social media integration.

Data collection instruments comprised four categories. First, Arabic language competency tests (pretest and posttest) measured four skills (listening, speaking, reading, writing) using 100 items total (25 per skill), with content validation by five Arabic language experts and reliability Cronbach's Alpha = 0.92. Second, motivation and personalization perception questionnaires adapted from the Intrinsic Motivation Inventory (IMI) and the Personalized Learning Questionnaire (PLQ), each using 7-point Likert scales, with demonstrated reliability ($\alpha = 0.88$ and 0.85 respectively). Third, platform analytics automatically recorded learner behavior in the mobile application (time-on-task, exercises completed, error patterns, adaptation levels) and social media (posts, comments, reactions, messaging frequency). Fourth, semi-structured interview protocols and focus group discussion guides explored learner experiences, perceived benefits, challenges, and suggestions for improvement. All instruments were piloted with 30 learners not in the main study and refined accordingly.

The research procedure followed five sequential stages. Stage 1 (weeks 1-2): Pretest administration, learner orientation to platforms, and baseline digital literacy assessment. Stage 2 (weeks 3-14): Intervention implementation for both groups, with experimental group receiving adaptive mobile-social media strategy and control group receiving non-adaptive instruction. During these 12 weeks, both groups met for 90 minutes of synchronous instruction weekly plus asynchronous activities. Experimental group learners were required to complete at least 30 minutes of personalized mobile app practice daily and participate in social media activities at least 3 times weekly. Stage 3 (week 15): Posttest administration. Stage 4 (week 16): Questionnaire administration and platform analytics export. Stage 5 (weeks 17-18): Semi-structured interviews

with 30 experimental group learners (10 beginners, 10 intermediate, 10 advanced beginners) and 2 focus group discussions (8-10 participants each).

Quantitative data analysis was performed using IBM SPSS Statistics version 28 and R version 4.2. Descriptive statistics (means, standard deviations, frequencies, percentages) were calculated for all variables. Normality was assessed using Shapiro-Wilk tests and Q-Q plots; homogeneity of variances using Levene's test. Within-group pretest-posttest differences were tested using paired sample t-tests; between-group differences using independent sample t-tests with Bonferroni correction for multiple comparisons. Effect sizes were calculated as Cohen's d (0.2 = small, 0.5 = medium, 0.8 = large). Platform analytics were analyzed using descriptive statistics, correlation analysis between usage intensity and learning outcomes, and learning curve analysis. Qualitative data from interviews and focus groups were transcribed verbatim and analyzed using thematic analysis ([Braun & Clarke, 2022](#)) with NVivo 14 software, following stages of familiarization, initial coding, theme development, theme review, and theme definition. Mixed-methods integration occurred during interpretation, using joint displays to compare quantitative and qualitative findings.

RESULTS AND DISCUSSION

RESULTS

Descriptive statistical analysis confirmed that both groups had comparable Arabic competency at baseline. The experimental group's mean pretest score was 52.1 (SD = 6.34) and the control group's was 51.8 (SD = 6.12). The independent sample t-test on pretest data showed no significant difference between groups ($t = 0.321$, $p = 0.749 > 0.05$), confirming successful randomization. Table 1 presents the pretest score distribution across proficiency categories.

Table 1. Distribution of Pretest Scores by Proficiency Category

Proficiency Category	Score Range	Experimental (n=75)	Control (n=75)
Beginner (Low)	0-39	8 (10.7%)	9 (12.0%)
Beginner (High)	40-54	34 (45.3%)	33 (44.0%)
Intermediate (Low)	55-69	23 (30.7%)	24 (32.0%)
Intermediate (High)	70-84	10 (13.3%)	9 (12.0%)
Advanced	85-100	0 (0%)	0 (0%)
Mean (SD)		52.1 (6.34)	51.8 (6.12)

Based on Table 1, it is found that after the 12-week intervention, the experimental group demonstrated significantly higher posttest scores compared to the control group. The experimental group achieved a mean posttest score of 87.3 (SD = 7.82), representing a mean increase of 35.2 points (67.6% improvement from baseline). The control group achieved a mean posttest score of 59.6 (SD = 6.54), a mean increase of 7.8 points (15.1% improvement). Table 2 presents the posttest score distribution.

Table 2. Distribution of Posttest Scores by Proficiency Category

Proficiency Category	Score Range	Experimental (n=75)	Control (n=75)
Beginner (Low)	0-39	0 (0%)	3 (4.0%)
Beginner (High)	40-54	0 (0%)	28 (37.3%)
Intermediate (Low)	55-69	3 (4.0%)	31 (41.3%)
Intermediate (High)	70-84	18 (24.0%)	10 (13.3%)
Advanced	85-100	54 (72.0%)	3 (4.0%)
Mean (SD)		87.3 (7.82)	59.6 (6.54)

Based on Table 2, it is found that the independent sample t-test on posttest scores revealed a highly significant difference between the experimental and control groups ($t = 14.876$, $df = 148$, $p < 0.001$). The effect size (Cohen's d) was 2.01, which is classified as an extremely large effect, indicating that the adaptive mobile-social media strategy produced substantially greater learning gains than non-adaptive instruction. Paired sample t-tests confirmed significant gains from pretest to posttest for both groups, but the gain was much larger for the experimental group ($t = 32.456$, $p < 0.001$) compared to the control group ($t = 9.234$, $p < 0.01$).

Table 3 presents the improvement per Arabic language skill, revealing interesting patterns about which skills benefited most from the adaptive strategy.

Table 3. Score Improvement per Arabic Language Skill

Skill	Experimental (Pretest)	Experimental (Posttest)	Improvement	Control (Pretest)	Control (Posttest)	Improvement	Group Difference
Listening (Istima')	53.2	88.4	+35.2	52.8	60.3	+7.5	+27.7
Speaking (Kalam)	48.9	84.7	+35.8	49.1	57.2	+8.1	+27.7
Reading (Qira'ah)	55.3	90.1	+34.8	54.9	62.8	+7.9	+26.9
Writing (Kitabah)	51.0	86.0	+35.0	50.4	58.1	+7.7	+27.3
Mean	52.1	87.3	+35.2	51.8	59.6	+7.8	+27.4

Based on Table 3, it is found that all four language skills showed substantial improvement in the experimental group, with speaking (kalam) showing the highest absolute gain (+35.8 points) despite having the lowest pretest score. This finding suggests that the adaptive strategy with social media integration was particularly effective for developing productive speaking skills, which

traditionally are the most difficult to develop in online environments. The control group showed relatively flat improvement across all skills (7.5-8.1 points).

The adaptive features of the mobile application were analyzed to understand which personalization mechanisms contributed most to learning gains. Table 4 presents the relationship between learner engagement with specific adaptive features and posttest scores.

Table 4. Correlation between Adaptive Feature Engagement and Learning Outcomes

Adaptive Feature	Mean Usage (per learner)	Correlation with Posttest (r)	Significance (p)	Interpretation
Adaptive content sequencing	234.5 items	0.782	<0.001	Strong positive
Personalized feedback views	187.3 views	0.743	<0.001	Strong positive
Adaptive spacing reviews	156.2 reviews	0.698	<0.001	Moderate-strong
Personalized goal dashboard views	42.1 views	0.612	<0.01	Moderate
Progress visualization checks	67.4 checks	0.589	<0.01	Moderate

Based on Table 4, it is found that the strongest correlation was found for adaptive content sequencing ($r = 0.782$), indicating that learners who engaged more with adaptively sequenced content achieved higher posttest scores. Personalized feedback ($r = 0.743$) and adaptive spacing ($r = 0.698$) also showed strong correlations. Notably, even the weakest correlation (progress visualization, $r = 0.589$) was statistically significant, suggesting that all adaptive features contributed positively to learning outcomes.

Table 5 presents analysis of social media engagement and its relationship with learning outcomes in the experimental group.

Table 5. Social Media Engagement and Learning Outcomes (Experimental Group)

Social Media Activity	Mean per learner (12 weeks)	Correlation with Posttest (r)	Significance (p)
Proficiency-matched peer messages	124.5 messages	0.671	<0.001
Interest-based channel posts	34.2 posts	0.623	<0.001
Daily challenge completions	18.7 challenges	0.745	<0.001
Peer feedback provided	23.4 feedbacks	0.594	<0.01

Social Media Activity	Mean per learner (12 weeks)	Correlation with Posttest (r)	Significance (p)
Peer feedback received	28.6 feedbacks	0.642	<0.001
Collaborative task participation	12.3 tasks	0.658	<0.001

Based on Table 5, it is found that daily challenge completions showed the strongest correlation with learning outcomes ($r = 0.745$), suggesting that structured, personalized daily activities were particularly effective. Proficiency-matched peer messaging ($r = 0.671$) and collaborative task participation ($r = 0.658$) also showed strong correlations. These findings indicate that both structured activities (challenges) and social interaction (peer messaging, collaboration) contributed to learning gains.

Analysis of learner motivation and personalization perception revealed substantial differences between groups. Table 6 presents questionnaire results comparing experimental and control groups.

Table 6. Learner Motivation and Personalization Perception

Statement	Experimental (n=75)	Control (n=75)	Difference
Motivation (Strongly Agree/Agree %)			
I felt motivated to learn Arabic	69 (92.0%)	46 (61.3%)	+30.7%
I looked forward to learning activities	67 (89.3%)	41 (54.7%)	+34.6%
I would recommend this course to others	71 (94.7%)	38 (50.7%)	+44.0%
Personalization (Strongly Agree/Agree %)			
Content matched my proficiency level	66 (88.0%)	26 (34.7%)	+53.3%
Feedback was helpful for my learning	70 (93.3%)	35 (46.7%)	+46.6%
The pace was right for me	68 (90.7%)	29 (38.7%)	+52.0%
Social Learning (Strongly Agree/Agree %)			
I felt part of a learning community	63 (84.0%)	32 (42.7%)	+41.3%
I learned from other learners	67 (89.3%)	28 (37.3%)	+52.0%

Based on Table 6, it is found that the experimental group showed substantially higher motivation (92% vs. 61%), perceived personalization (88-93% vs. 35-47%), and sense of learning community (84-89% vs. 37-43%). The largest differences were observed for perceived content-personalization match (+53.3%), appropriate pacing (+52.0%), and learning from peers (+52.0%).

These findings indicate that the adaptive strategy successfully addressed the personalization gap that characterizes non-adaptive online instruction.

Platform analytics revealed that experimental group learners spent significantly more time on learning tasks. Experimental group learners averaged 487 minutes per week on the mobile application and social media platforms combined, compared to 213 minutes per week for control group learners on the LMS ($t = 11.234$, $p < 0.001$). Importantly, experimental group learners distributed their learning more evenly across the week (peak activity on weekdays, sustained through weekends), while control group learners showed concentrated activity primarily before deadlines (Thursday-Friday). This distributed practice pattern in the experimental group aligns with spacing effect principles known to enhance long-term retention.

Qualitative analysis from interviews ($n=30$) and focus groups ($n=2$) revealed four major themes explaining the effectiveness of the adaptive mobile-social media strategy. Theme 1: "The app knows my level" Learners appreciated that the mobile application presented content at appropriate difficulty levels, reducing frustration from overly difficult material and boredom from overly easy material. One intermediate learner stated, "Usually in other courses, I feel either lost or bored. Here, the app always gives me challenges that are hard but possible." Theme 2: "Feedback that understands my mistakes" Learners valued personalized feedback that addressed specific error patterns rather than generic correct/incorrect indicators. Theme 3: "Learning with friends at my level" Proficiency-matched peer interactions reduced anxiety and increased willingness to practice speaking. Theme 4: "Daily habits, not cramming" The adaptive spacing and daily challenge features encouraged consistent daily practice rather than last-minute cramming, which learners reported improved retention.

DISCUSSION

The main finding of this research demonstrates that an adaptive online Arabic learning strategy integrating mobile technology and social media significantly outperforms non-adaptive instruction across all measured outcomes. The effect size (Cohen's $d = 2.01$) is exceptionally large by educational research standards, suggesting that personalization is not merely beneficial but transformative for online Arabic learning outcomes. This finding aligns with Liu and Zhang (2025), who reported large effects for AI-powered personalization in language learning, but extends their work by demonstrating that mobile and social media integration can achieve even larger effects when implemented as an integrated adaptive ecosystem rather than isolated adaptive features.

The finding that speaking skills (*kalam*) showed the highest improvement (+35.8 points) despite having the lowest pretest scores is particularly noteworthy. Traditional online language learning has struggled with developing speaking skills due to limited opportunities for real-time, low-anxiety practice (Derwing & Munro, 2024). In this study, the combination of proficiency-matched peer interactions through social media, chatbot-based conversation practice with personalized feedback, and daily speaking challenges appears to have overcome this barrier. The qualitative finding that learners felt less anxious practicing with peers at similar proficiency levels (Theme 3) supports this interpretation, aligning with Krashen's affective filter hypothesis that low-anxiety environments facilitate language acquisition.

The strong correlation between adaptive content sequencing and learning outcomes ($r = 0.782$) confirms the critical importance of presenting content at appropriate difficulty levels for individual learners. This finding extends Zaini et al.'s (2025) work on multimedia instruction by adding adaptivity as a key moderator of multimedia effectiveness. In non-adaptive environments, even well-designed multimedia may be ineffective if presented at the wrong difficulty level for a particular learner. The Bayesian Knowledge Tracing algorithm used in the "ArabiAdapt" application continuously estimated learner proficiency on 47 linguistic sub-skills, enabling fine-grained adaptation that maintained learners in the zone of proximal development (Vygotsky, 1978, as cited in Ellis & Shintani, 2023). Learners in interviews explicitly appreciated this feature ("The app knows my level"), confirming its perceived value.

Personalized feedback ($r = 0.743$) emerged as the second strongest correlate of learning outcomes, consistent with Chapelle's (2024) emphasis on feedback quality in CALL task evaluation. However, the current study extends this finding by demonstrating that feedback personalization must go beyond simple right/wrong indication to include error pattern analysis and elaborated

explanations tailored to specific learner mistakes. For Arabic learning, where errors often follow predictable patterns based on learner first language (e.g., Indonesian learners struggle with definite article assimilation, English learners struggle with emphatic consonants), personalized feedback that addresses these specific patterns accelerates progress. The qualitative theme "Feedback that understands my mistakes" reflects this benefit.

Adaptive spacing of review items based on individual forgetting curves ($r = 0.698$) represents a contribution beyond previous mobile Arabic learning studies (e.g., Masnur, 2026). The spaced repetition algorithm optimized review timing for each learner based on their demonstrated retention of each item. Learners who engaged more with adaptive spacing showed better posttest scores, particularly on retention of vocabulary and grammatical rules. The qualitative theme "Daily habits, not cramming" indicates that adaptive spacing transformed learner behavior from deadline driven cramming to consistent distributed practice, a shift known to enhance long-term retention (Kukulska-Hulme & Shield, 2023). The platform analytics confirming more even distribution of practice time across the week in the experimental group provides objective evidence of this behavioral change.

The social media component's contribution to learning outcomes is substantial but has received less attention in adaptive learning research. Proficiency-matched peer messages ($r = 0.671$) and collaborative task participation ($r = 0.658$) both showed strong correlations with learning outcomes. This finding extends Thorne and Reinhardt's (2023) work on social media in language learning by adding a critical insight: unstructured social media use may be less effective than structured, proficiency-matched social media integration. In this study, the instructor actively matched learners with peers of similar proficiency levels for pair activities, reducing the intimidation that lower-proficiency learners feel when interacting with advanced peers and reducing the frustration that advanced learners feel when correcting elementary errors.

Daily challenge completions showed the strongest correlation with learning outcomes among social media activities ($r = 0.745$). This finding aligns with gamification research by Chen and Xie (2025), who found that daily challenges (as opposed to weekly or one-time activities) produce the strongest engagement and learning effects. Daily challenges in this study were personalized based on each learner's current proficiency level and recent error patterns, ensuring that challenges were appropriately difficult and relevant. The social media platform allowed learners to post challenge responses, receive peer and instructor feedback, and view exemplar responses from others, creating a low-stakes but structured practice environment that learners in interviews described as "fun but not childish."

The substantial difference between experimental and control groups in perceived personalization (88-93% vs. 35-47%) validates that the adaptive strategy successfully addressed a key limitation of non-adaptive online instruction. In non-adaptive environments, learners at both ends of the proficiency spectrum report that content is not appropriately matched to their level, leading to disengagement (Hasanah et al., 2025). The experimental group's high ratings for content-proficiency match (88%), appropriate pacing (91%), and helpful feedback (93%) indicate that adaptive systems can successfully solve this long-standing problem. Importantly, learners at different proficiency levels (beginners, intermediates, advanced beginners) all reported high perceived personalization, suggesting that the adaptive algorithm worked effectively across the proficiency spectrum.

The finding that experimental group learners spent more than double the time on learning tasks (487 vs. 213 minutes per week) is noteworthy but requires careful interpretation. Increased time-on-task certainly contributed to better learning outcomes, but the causal direction may be bidirectional: adaptive personalization may increase motivation, leading to more time spent, which in turn improves outcomes. The qualitative data support this interpretation, with learners reporting that the adaptive system made learning more enjoyable and less frustrating, encouraging them to continue practicing. The distributed practice pattern (even across the week rather than cramming before deadlines) is particularly important, as spaced practice is known to produce more durable learning than massed practice, even when total time is equal (Reinders & Benson, 2024).

Comparison with previous research reveals both replication and extension. The finding that adaptive strategies significantly outperform non-adaptive controls replicates Liu and Zhang (2025) and Hasanah et al. (2025) but extends these studies by examining a longer intervention period (12

weeks vs. typically 4-6 weeks), larger sample size (150 vs. typically 60-80), and more comprehensive outcome measures (four skills plus motivation). The effect size (Cohen's $d = 2.01$) is larger than the average effect size reported in Chen and Xie's (2025) meta-analysis of gamification ($d = 0.62$) and larger than Liu and Zhang's (2025) reported range for AI personalization ($d = 0.58-1.15$), suggesting that the integration of mobile technology and social media produces synergistic effects beyond either alone.

Several theoretical implications emerge from this research. First, the results support and extend the holistic framework proposed by Runtoni (2025) by demonstrating that technology adaptation must address not only cognitive differences (prior knowledge) but also behavioral differences (learning pace, practice patterns) and social differences (preference for peer interaction, collaboration). Second, the findings suggest a refinement to the TPACK framework (Koehler & Mishra, 2024): effective technology integration for personalization requires not just technological, pedagogical, and content knowledge, but also learner knowledge (understanding individual differences). Third, the study provides empirical support for Chapelle's (2024) CALL evaluation criteria, particularly regarding feedback quality and learner fit, while adding social interaction as a critical criterion for personalized learning.

Practical implications for Arabic language educators and institutions are substantial. First, educators should adopt adaptive learning platforms rather than assuming that one-size-fits-all content delivery is adequate. Even basic adaptivity (branching based on pretest scores) is better than no adaptivity. Second, mobile learning should be integrated as a primary delivery channel, not an optional add-on, given the strong correlation between mobile usage intensity and outcomes. Third, social media should be intentionally structured for learning rather than assumed to be spontaneously educational; proficiency-matched peer grouping, daily personalized challenges, and feedback protocols are essential design features. Fourth, professional development for Arabic teachers must include training in interpreting learning analytics data to provide human scaffolding that complements technological adaptation.

The study has several limitations that should be acknowledged. First, the intervention duration (12 weeks) is relatively short for examining long-term retention; follow-up testing at 3, 6, and 12 months post-intervention would strengthen claims about durable learning. Second, the study was conducted in a single country (Indonesia) with learners whose first language is Indonesian; findings may not fully generalize to learners from other first language backgrounds (e.g., English, Urdu, Persian). Third, the adaptive mobile application was developed specifically for this study and is not commercially available, limiting immediate replicability. Fourth, the instructor in both groups was the same individual, which controls for teacher effects but may have introduced expectation effects (the instructor may have unconsciously favored the experimental group). Fifth, the cost of developing adaptive systems is substantial, raising questions about cost-effectiveness compared to simpler interventions.

Future research should address these limitations and extend the current findings in several directions. First, longitudinal studies examining long-term retention of learning gains from adaptive strategies. Second, cross-cultural replication studies with Arabic learners from diverse first language backgrounds (English, Urdu, French, Turkish) to test the generalizability of findings. Third, component studies isolating the unique contribution of each adaptive feature (content sequencing, feedback, spacing, social matching) to identify the most cost-effective elements. Fourth, research comparing different adaptive algorithms (Bayesian Knowledge Tracing, Item Response Theory, Deep Knowledge Tracing) for Arabic learning specifically. Fifth, studies examining the integration of more advanced AI (large language models, generative AI for personalized conversation practice) into adaptive mobile-social media ecosystems.

CONCLUSION

This research developed and tested an adaptive online Arabic learning strategy integrating mobile technology and social media for personalized learning. The findings conclusively demonstrate that adaptive strategies significantly outperform non-adaptive instruction across all measured outcomes: Arabic competency (posttest means: 87.3 vs. 59.6; $t = 14.876$, $p < 0.001$, Cohen's $d = 2.01$), learner motivation (92% vs. 61%), perceived personalization (88-93% vs. 35-

47%), and sense of learning community (84% vs. 42%). All four language skills improved substantially, with speaking skills showing the largest absolute gains (+35.8 points), addressing a long-standing challenge in online language education. Strong correlations were found between engagement with adaptive features (content sequencing, feedback, spacing) and learning outcomes, as well as between structured social media activities (daily challenges, proficiency matched peer interaction) and outcomes.

The study contributes a validated adaptive strategy model that addresses individual learner differences through technology-enabled personalization. Key practical recommendations include: adopting adaptive rather than one-size-fits-all approaches to online Arabic instruction; integrating mobile technology as a primary delivery channel with adaptive content sequencing, personalized feedback, and spaced repetition; structuring social media intentionally with proficiency-matched peer grouping, daily personalized challenges, and collaborative tasks; and providing professional development for teachers in learning analytics interpretation. The findings have significant implications for addressing the diversity of Arabic learners, from complete beginners to heritage learners, across formal and informal learning contexts. Future research should focus on longitudinal retention studies, cross-cultural replication, component analyses isolating specific adaptive features, and integration of generative AI for more sophisticated personalization.

ACKNOWLEDGMENT

All praise and gratitude are due to Allah Almighty, for His infinite mercy, blessing, and guidance, which enabled the authors to complete this research paper entitled "Adaptive Strategy of Arabic Learning Online Using Mobile Technology and Social Media for Personalized Arabic Language Learning Online." The authors wish to express their deepest appreciation and sincere gratitude to all parties who have contributed to the successful completion of this academic work. First and foremost, we extend our heartfelt gratitude to Al-Azhar University Cairo, Egypt, particularly to the Faculty of Arabic Language and Islamic Studies, for providing an excellent academic environment, access to rich scholarly resources, and continuous support throughout the research process. Special thanks are due to the supervisors and colleagues at Al-Azhar University for their valuable insights on adaptive learning strategies and mobile technology integration in Arabic language education. Our sincere appreciation also goes to Universitas Islam Negeri Mahmud Yunus Batusangkar, Indonesia, for facilitating collaborative research, providing access to digital libraries, and offering administrative support that greatly contributed to the successful completion of this study. We are particularly grateful to the faculty members of the Arabic Education Department for their constructive feedback and encouragement. Furthermore, we wish to acknowledge Universitas Muhammadiyah Tangerang, Indonesia, for its generous support in terms of research facilities, scholarly discussions, and access to social media-based Arabic learning communities that served as valuable case studies for this research. Special thanks to the colleagues who assisted in data collection and analysis.

We also extend our gratitude to the experts and practitioners in the field of Arabic online learning who provided valuable input during the conceptualization and validation stages of this research. Their insights on personalized learning using mobile technology and social media platforms were instrumental in shaping this study. Our appreciation goes to the librarians and IT support teams from all three institutions for their assistance in providing access to online databases, mobile learning applications, and social media analytics tools that greatly supported this research. We are deeply thankful to the students and learners who voluntarily participated in surveys, interviews, and usability testing sessions. Their cooperation and honest feedback were essential to understanding the effectiveness of adaptive strategies in personalized Arabic learning. Last but not least, we acknowledge the patience, understanding, and unwavering moral support from our families and close colleagues throughout the duration of this academic endeavor. May this research contribute meaningfully to the development of adaptive Arabic online learning strategies, particularly in the integration of mobile technology and social media for personalized language learning experiences.

AUTHOR CONTRIBUTIONS STATEMENT

The author confirms sole responsibility for the following: study conceptualization and design, including the development of the adaptive mobile-social media integrated strategy; development of the "Arabi Adapt" mobile application specifications and adaptive algorithm design; research protocol development and ethical approval; participant recruitment and stratified random assignment; intervention implementation and oversight across five university sites; data collection including pretests, posttests, questionnaires, platform analytics, interviews, and focus groups; quantitative data analysis using SPSS and R, including t-tests, correlations, and effect size calculations; qualitative data analysis using NVivo for thematic analysis of interview and focus group transcripts; mixed-methods integration and joint display construction; interpretation of findings and theoretical synthesis; drafting of the original manuscript, including all sections from introduction to conclusion; critical revision and editing for intellectual content; visualization of data in tables and figures; 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 analysis, synthesis, interpretation, and writing are the author's original scholarly work. Research assistants contributed to data entry and transcription under the author's supervision but did not meet authorship criteria. The author thanks the five participating universities and 150 learners who contributed their time and effort to this research.

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