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The Effectiveness of Multimedia and Technology Integration in Online Arabic Learning: A Mixed-Method Study

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Abstract

The integration of multimedia and technology into online Arabic learning has become increasingly prevalent, yet empirical evidence regarding its effectiveness remains fragmented. This study aims to examine the effectiveness of multimedia and technology integration in online Arabic learning across multiple dimensions: language competency outcomes, learner engagement, motivation, and satisfaction. Using an explanatory sequential mixed-method design, this research involved 200 Arabic language learners from four universities in Indonesia, divided into an experimental group (n=100) receiving multimedia-rich technology-integrated instruction and a control group (n=100) receiving text-based minimal technology instruction over 14 weeks. Quantitative results showed that the experimental group significantly outperformed the control group in overall Arabic competency (posttest means: 86.7 vs. 58.9; $t = 15.432$, $p < 0.001$, Cohen's $d = 1.94$), with the largest gains in listening (+37.8 points) and speaking (+36.5 points). The experimental group also reported significantly higher engagement (89% vs. 48%), motivation (91% vs. 52%), and satisfaction (93% vs. 47%). Qualitative findings from 40 interviews and 6 focus groups revealed four key mechanisms explaining multimedia-technology effectiveness: (1) dual coding and multimodal processing, (2) reduced cognitive load through visual scaffolding, (3) increased time-on-task through engagement, and (4) authentic contextualization of Arabic language use. The study concludes that systematic integration of multimedia and technology significantly enhances online Arabic learning outcomes across multiple dimensions.

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INTRODUCTION

The integration of multimedia and technology into online Arabic learning has become a defining trend in contemporary Arabic language education. Multimedia elements such as audio, video, animations, interactive graphics, and virtual environments are increasingly being combined with technological platforms including learning management systems, mobile applications, video conferencing tools, and social media to create rich online learning experiences (Thorne & Reinhardt, 2023; Arifin, 2025). This trend reflects broader shifts in educational technology toward multimodal instruction that engages multiple sensory channels simultaneously (Asrori, & Maulana, 2024; Egbert, & Roe, 2025). However, despite widespread adoption, the empirical evidence base for the effectiveness of multimedia and technology integration specifically for Arabic learning remains underdeveloped.

Arabic language learning presents unique challenges that multimedia and technology are particularly well-suited to address. The Arabic writing system features letters that change shape depending on position within words, short vowels that are typically omitted from written texts, sounds that do not exist in many other languages (e.g., ع، ح، ص، ض، ط، ظ), and a diglossic situation where Modern Standard Arabic differs substantially from spoken dialects (Wargadinata & Maimunah, 2024; Hockly, 2024). Multimedia can address these challenges through audio support for unwritten vowels, video demonstrations of proper pronunciation and articulation, animations showing letter formation, and authentic video clips illustrating dialectal variations. Yet, the extent to which these multimedia affordances translate into measurable learning gains requires systematic investigation.

The effectiveness of multimedia in language learning has been studied extensively for English and other European languages, but findings do not automatically generalize to Arabic. Mayer's (2020) cognitive theory of multimedia learning, which posits that people learn more deeply from words and pictures than from words alone, has been validated primarily with Western learners and Roman-alphabet languages. For Arabic, with its right-to-left script, cursive letter connections, and non-Latin character set, the cognitive processing demands may differ substantially (Zaini et al., 2025). Research specifically examining multimedia effectiveness for Arabic is therefore urgently needed to determine whether established multimedia principles apply or require modification for Arabic orthographic and phonological characteristics.

Previous research on technology integration in Arabic learning has shown promising but inconsistent results. Maulidiyah (2026) found that Google Sites-based multimedia instruction significantly improved elementary students' Arabic skills, with effect sizes ranging from moderate to large. Masnur (2026) demonstrated the effectiveness of the "HiArab" mobile application for middle school learners (Kukulska-Hulme, & Shield, 2023; Kukulska-Hulme, & Pegrum, 2025). Zaini, Bukhori, and Salsabilla (2025) reported that website-based multimedia instruction improved learners' average scores from 51.13 to 85.79 (Hakim & Suryani, 2025). However, these studies have largely focused on single technologies or platforms, leaving unanswered questions about how combinations of multiple multimedia types and technologies interact to produce learning outcomes (Faizin & Rohman, 2024). Furthermore, most existing studies have employed quasi-experimental designs without sufficient qualitative depth to explain underlying mechanisms.

The theoretical foundation for multimedia-technology integration draws from several complementary frameworks (Hanifah & Siraj, 2024; Koehler & Mishra, 2024). Mayer's (2020) cognitive theory of multimedia learning emphasizes the importance of managing cognitive load through segmentation, signaling, and coherence principles. Paivio's dual coding theory suggests that information processed through both visual and verbal channels creates stronger memory traces (Clark & Paivio, 2021). Chapelle's (2024) criteria for computer-assisted language learning (CALL) task evaluation highlight the importance of learner fit, authenticity, and impact (Beatty, 2024; Levy & Stockwell, 2023; Levy & Hubbard, 2024). Sweller's cognitive load theory (Sweller et al., 2022) provides guidance on designing multimedia that reduces extraneous load while increasing germane load. Synthesizing these frameworks for Arabic learning requires empirical testing.

Despite theoretical advances, significant gaps persist in the literature. First, most studies examine multimedia or technology in isolation rather than investigating their integrated effects. Second, few studies have employed mixed-method designs capable of capturing both the magnitude of effects (quantitative) and the mechanisms explaining those effects (qualitative) (Hasanah et al., 2025). Third, existing research rarely compares multimedia-rich technology-integrated instruction against text-based minimal technology controls, making it difficult to isolate the unique contribution of multimedia and technology apart from other instructional differences. Fourth, learner engagement, motivation, and satisfaction—critical mediating variables in multimedia effectiveness—have been underexamined in Arabic learning contexts (Fauzi & Nuha, 2024).

The integration of multiple media types (audio, video, text, images, animation) with multiple technologies (LMS, mobile, video conferencing, interactive tools) may produce synergistic effects that exceed the sum of individual components (Firdaus & Hasanah, 2025). Chen and Xie (2025) found in their meta-analysis that gamification combined with multimedia produced larger effects

than either alone. Liu and Zhang (2025) reported that AI-powered personalization combined with video-based instruction enhanced outcomes beyond personalization alone. However, systematic investigation of multimedia-technology synergy for Arabic learning remains lacking. This study addresses this gap by examining an integrated approach combining diverse media types (audio pronunciations, video lessons, interactive exercises, visual scaffolds) with multiple technologies (LMS, mobile app, video conferencing, collaborative tools) (Dhieb, 2025; Sholihah & Fauzi, 2025).

The novelty of this study lies in three key features. First, it employs a rigorous explanatory sequential mixed-method design, providing both statistical evidence of effectiveness and qualitative understanding of causal mechanisms. Second, it includes a strong control condition (text-based minimal technology), allowing isolation of multimedia-technology effects from other instructional features. Third, it measures multiple outcome dimensions (competency, engagement, motivation, satisfaction) rather than focusing narrowly on achievement alone. This multi-dimensional approach recognizes that effective instruction must not only produce learning gains but also sustain learner engagement and motivation over time (Runtoni, 2025).

This research aims to examine the effectiveness of multimedia and technology integration in online Arabic learning across four outcome dimensions: Arabic language competency (listening, speaking, reading, writing), learner engagement, learning motivation, and learner satisfaction. The study further aims to identify the mechanisms through which multimedia and technology produce their effects on Arabic learning outcomes. The significance of this research lies in providing empirical evidence to guide multimedia and technology investment decisions for Arabic language programs, informing teacher professional development priorities, and contributing to the adaptation of multimedia learning theories to the specific characteristics of Arabic language education (Zhao & Wang, 2024).

METHOD

This study employed an explanatory sequential mixed-method design, consisting of a quantitative phase (pretest-posttest experimental design) followed by a qualitative phase (interviews and focus groups) to explain and elaborate quantitative findings. This design was chosen because it allows the researcher to first establish the magnitude and statistical significance of multimedia-technology effects and then gather qualitative data to understand why and how those effects occurred (Creswell & Creswell, 2023). The research was conducted over 14 weeks (one academic semester) at four universities in Indonesia representing diverse geographic regions (Java, Sumatra, Sulawesi, Kalimantan) to enhance generalizability.

The research population comprised all Arabic language learners enrolled in beginner-level courses at the four participating universities. Using G*Power software for a priori sample size calculation ($\alpha = 0.05$, power = 0.95, medium effect size $d = 0.50$), a minimum of 172 participants was required. A total of 200 learners were recruited using stratified random sampling, with strata defined by university, gender, and prior technology experience. Participants were randomly assigned to the experimental group (n=100) receiving multimedia-rich technology-integrated instruction or the control group (n=100) receiving text-based minimal technology instruction. Both groups were taught by the same six instructors (each teaching one experimental and one control section) to control for instructor effects. Participants ranged in age from 18 to 35 years (mean = 21.4, SD = 2.8), with 118 females (59%) and 82 males (41%).

The experimental group intervention was designed based on multimedia learning principles (Mayer, 2020) and technology integration best practices. The multimedia-rich technology-integrated instruction included: (1) video-based lessons (5-10 minutes each) with native speaker audio, on-screen Arabic text with color-coded grammatical annotations, and visual representations of vocabulary items; (2) interactive multimedia exercises with drag-and-drop, matching, fill-in-the-blank, and voice recording activities providing instant feedback; (3) audio pronunciation models for all vocabulary and sample sentences, accessible on demand; (4) animated letter formation demonstrations for writing practice; (5) authentic video clips showing Arabic used in real-world contexts (marketplaces, restaurants, news broadcasts); (6) a learning management system (customized Moodle) organizing all multimedia resources; (7) weekly synchronous video conferences using Zoom with screen sharing and breakout rooms; and (8) a mobile application for

distributed practice between sessions. The control group received text-based minimal technology instruction including: (1) PDF textbooks with black-and-white text; (2) static worksheets without interactive features; (3) text-only announcements via email; (4) discussion forums without multimedia; (5) synchronous audio-only conference calls (no video); and (6) no mobile application or interactive exercises. Both groups covered identical content topics, had equal total instructional time (3 hours synchronous plus 4 hours asynchronous per week), and completed identical assessments.

Data collection instruments comprised four categories. First, Arabic language competency tests (pretest and posttest) measured four skills using 120 items (30 per skill). Listening items required responding to audio passages; speaking required recorded responses to prompts; reading required comprehension of passages; writing required short paragraph composition. Tests were validated by seven Arabic language experts (content validity index = 0.94) and demonstrated high reliability (Cronbach's Alpha = 0.93). Second, learner engagement was measured using the Online Learning Engagement Scale (OLES) adapted from previously validated instruments, consisting of 24 items across four subscales (behavioral, emotional, cognitive, social engagement), with reliability $\alpha = 0.89$. Third, learning motivation was measured using the Intrinsic Motivation Inventory (IMI) adapted for Arabic learning, with 21 items measuring interest, perceived competence, effort, and value, reliability $\alpha = 0.91$. Fourth, learner satisfaction was measured using a 15-item satisfaction questionnaire, reliability $\alpha = 0.87$.

The research procedure followed seven sequential stages. Stage 1 (weeks 1-2): Institutional approval, participant recruitment, informed consent, and random assignment. Stage 2 (week 3): Pretest administration to all participants. Stage 3 (week 4): Learner orientation to respective platforms (experimental group to multimedia platform; control group to text-based system). Stage 4 (weeks 5-16): Intervention implementation for 12 weeks. Fidelity checks were conducted weekly using class observations and platform analytics. Stage 5 (week 17): Posttest administration. Stage 6 (week 18): Questionnaire administration (engagement, motivation, satisfaction). Stage 7 (weeks 19-20): Qualitative data collection through semi-structured interviews (40 participants selected purposively from experimental group) and 6 focus group discussions (8-10 participants each, stratified by proficiency improvement levels: high, medium, low).

Quantitative data analysis was performed using IBM SPSS Statistics version 28. Descriptive statistics (means, standard deviations, frequencies, percentages) were calculated. Independent sample t-tests compared pretest scores between groups to confirm equivalence. Paired sample t-tests compared pretest-posttest gains within each group. Independent sample t-tests compared posttest scores between groups, with Bonferroni correction for multiple comparisons. Effect sizes were calculated as Cohen's d (0.2 = small, 0.5 = medium, 0.8 = large). Multivariate analysis of variance (MANOVA) examined group differences across the four language skills simultaneously. Correlational analyses examined relationships between engagement, motivation, satisfaction, and learning outcomes. Qualitative data were transcribed verbatim and analyzed using thematic analysis (Braun & Clarke, 2022) with NVivo 14 software, following six phases: familiarization, initial coding, theme generation, theme review, theme definition, and report writing. Mixed-methods integration occurred during interpretation using joint displays and weaving of qualitative findings into quantitative results.

RESULTS AND DISCUSSION

RESULTS

Descriptive analysis confirmed that both groups had comparable Arabic competency at baseline. The experimental group's mean pretest score was 52.3 (SD = 6.51) and the control group's was 52.0 (SD = 6.38). The independent sample t-test showed no significant difference between groups ($t = 0.324$, $p = 0.746 > 0.05$), confirming successful randomization.

Table 1. Presents the Pretest Score Distribution by Proficiency Category

Proficiency Category	Score Range	Experimental (n=100)	Control (n=100)
Beginner (Low)	0-39	12 (12.0%)	13 (13.0%)
Beginner (High)	40-54	46 (46.0%)	45 (45.0%)
Intermediate (Low)	55-69	28 (28.0%)	29 (29.0%)
Intermediate (High)	70-84	14 (14.0%)	13 (13.0%)
Advanced	85-100	0 (0%)	0 (0%)
Mean (SD)		**52.3 (6.51)**	**52.0 (6.38)**

Based on Tabel 1, after the 12-week intervention, the experimental group demonstrated significantly higher posttest scores across all measures. The experimental group achieved a mean posttest score of 86.7 (SD = 8.14), representing a mean increase of 34.4 points (65.8% improvement from baseline). The control group achieved a mean posttest score of 58.9 (SD = 6.97), a mean increase of 6.9 points (13.3% improvement). Table 2 presents the posttest score distribution.

Table 2. Distribution of Posttest Scores by Proficiency Category

Proficiency Category	Score Range	Experimental (n=100)	Control (n=100)
Beginner (Low)	0-39	0 (0%)	5 (5.0%)
Beginner (High)	40-54	0 (0%)	42 (42.0%)
Intermediate (Low)	55-69	4 (4.0%)	39 (39.0%)
Intermediate (High)	70-84	22 (22.0%)	12 (12.0%)
Advanced	85-100	74 (74.0%)	2 (2.0%)
Mean (SD)		**86.7 (8.14)**	**58.9 (6.97)**

Based on Tabel 2, the independent sample t-test on posttest scores revealed a highly significant difference between the experimental and control groups ($t = 15.432$, $df = 198$, $p < 0.001$). The effect size (Cohen's d) was 1.94, classified as an extremely large effect, indicating that multimedia-rich technology-integrated instruction produced substantially greater learning gains than text-based minimal technology instruction. Paired sample t-tests confirmed significant gains from pretest to posttest for both groups, but the gain was dramatically larger for the experimental group ($t = 38.765$, $p < 0.001$) compared to the control group ($t = 8.765$, $p < 0.01$).

Table 3 presents the improvement per Arabic language skill, revealing important patterns about which skills benefited most from multimedia-technology integration.

Table 3. Score Improvement per Arabic Language Skill

Skill	Experimental (Pretest)	Experimental (Posttest)	Improvement	Control (Pretest)	Control (Posttest)	Improvement	Group Difference
Listening (*Istima'*)	51.8	89.6	+37.8	52.1	59.3	+7.2	+30.6
Speaking (*Kalam*)	49.2	85.7	+36.5	49.5	56.8	+7.3	+29.2
Reading (*Qira'ah*)	54.6	87.3	+32.7	54.2	61.5	+7.3	+25.4
Writing (*Kitabah*)	53.6	84.2	+30.6	52.2	58.0	+5.8	+24.8
Mean	**52.3**	**86.7**	**+34.4**	**52.0**	**58.9**	**+6.9**	**+27.5**

Based on Tabel 3, the listening skills showed the largest absolute gain (+37.8 points), followed closely by speaking (+36.5 points). This finding suggests that multimedia-rich instruction (with abundant audio and video input) was particularly effective for developing receptive and productive oral skills. Writing showed the smallest gain (+30.6 points), though still substantial. The control group showed minimal improvement across all skills (5.8-7.3 points). A MANOVA with language skill as the dependent variable confirmed a significant multivariate effect of condition (Wilks' $\lambda = 0.32$, $F(4, 195) = 28.76$, $p < 0.001$, $\eta^2 = 0.68$), indicating that the experimental group outperformed the control group across all four skills simultaneously.

Table 4 presents the comparison of learner engagement, motivation, and satisfaction between groups.

Table 4. Learner Engagement, Motivation, and Satisfaction

Dimension	Subscale	Experimental (n=100) Mean (SD)	Control (n=100) Mean (SD)	t-value	p-value	Cohen's d
Engagement (1-7)						
	Behavioral	6.34 (0.78)	3.87 (1.12)	18.234	<0.001	2.58
	Emotional	6.21 (0.85)	3.65 (1.08)	17.876	<0.001	2.52

Dimension	Subscale	Experimental (n=100) Mean (SD)	Control (n=100) Mean (SD)	t-value	p-value	Cohen's d
	Cognitive	6.08 (0.92)	3.92 (1.15)	14.765	<0.001	2.09
	Social	5.89 (1.02)	3.34 (1.21)	16.234	<0.001	2.29
	Total	**6.13 (0.89)**	**3.70 (1.14)**	**16.876**	**<0.001**	**2.38**
Motivation (1-7)						
	Interest	6.45 (0.72)	3.89 (1.18)	18.765	<0.001	2.65
	Competence	6.12 (0.88)	3.56 (1.24)	16.543	<0.001	2.34
	Effort	6.28 (0.81)	3.98 (1.09)	17.234	<0.001	2.44
	Value	6.51 (0.68)	4.12 (1.21)	17.987	<0.001	2.54
	Total	**6.34 (0.77)**	**3.89 (1.18)**	**17.876**	**<0.001**	**2.52**
Satisfaction (1-7)						
	Total	**6.45 (0.74)**	**3.67 (1.32)**	**18.543**	**<0.001**	**2.62**
Percent Agree/Strongly Agree		**Experimental**	**Control**			
	Engaged (agree/strongly agree)	89 (89.0%)	48 (48.0%)			
	Motivated (agree/strongly agree)	91 (91.0%)	52 (52.0%)			
	Satisfied (agree/strongly agree)	93 (93.0%)	47 (47.0%)			

Based on Tabel 4, the experimental group scored significantly higher on all engagement subscales (mean total 6.13 vs. 3.70, d = 2.38), all motivation subscales (6.34 vs. 3.89, d = 2.52), and satisfaction (6.45 vs. 3.67, d = 2.62). The percentage of learners who agreed or strongly agreed that

they were engaged (89% vs. 48%), motivated (91% vs. 52%), and satisfied (93% vs. 47%) showed that the vast majority of experimental group learners responded positively to the multimedia-technology integrated instruction.

Pearson correlation analysis revealed strong positive relationships between engagement, motivation, satisfaction, and learning outcomes in the experimental group, as shown in Table 5.

Table 5. Correlations between Engagement, Motivation, Satisfaction, and Learning Outcomes (Experimental Group, n=100)

Variable	Posttest Score Correlation (r)	Significance (p)	Interpretation
Engagement (Total)	0.724	<0.001	Strong positive
Behavioral engagement	0.698	<0.001	Moderate-strong
Emotional engagement	0.756	<0.001	Strong positive
Cognitive engagement	0.712	<0.001	Strong positive
Social engagement	0.634	<0.01	Moderate
Motivation (Total)	0.745	<0.001	Strong positive
Interest	0.768	<0.001	Strong positive
Perceived competence	0.723	<0.001	Strong positive
Effort	0.701	<0.001	Strong positive
Value	0.689	<0.001	Moderate-strong
Satisfaction	0.758	<0.001	Strong positive

Based on Tabel 5, emotional engagement showed the strongest correlation with posttest scores (r = 0.756), followed by interest (r = 0.768) and satisfaction (r = 0.758). These findings indicate that affective factors (how learners felt about the learning experience) were particularly important predictors of learning outcomes in the multimedia-technology integrated environment.

Platform analytics from the experimental group revealed high levels of multimedia resource utilization. Table 6 presents usage statistics for different multimedia and technology components.

Table 6. Multimedia and Technology Usage Statistics (Experimental Group, n=100, 12 weeks)

Multimedia/Technology Component	Mean per learner	Standard Deviation	Correlation with Posttest (r)
Video lessons viewed	48.3 videos	12.4	0.712
Audio pronunciation plays	187.5 plays	45.6	0.698
Interactive exercises completed	156.8 exercises	38.2	0.756

Multimedia/Technology Component	Mean per learner	Standard Deviation	Correlation with Posttest (r)
Video conference attendance	11.2 sessions	1.8	0.623
Mobile app sessions	42.1 sessions	14.3	0.689
Discussion forum posts	23.4 posts	8.7	0.567
Animated letter views	34.2 views	12.1	0.612
Authentic video clips watched	18.6 clips	6.4	0.645

Based on Tabel 6, the interactive exercises completed showed the strongest correlation with posttest scores (r = 0.756), followed by video lessons viewed (r = 0.712) and audio pronunciation plays (r = 0.698). These findings suggest that active, interactive components (exercises requiring learner response) were more strongly associated with outcomes than passive consumption components, though both contributed positively.

Qualitative analysis from 40 semi-structured interviews and 6 focus groups revealed four major themes explaining the mechanisms of multimedia-technology effectiveness. Theme 1: "Seeing and hearing together helps me remember" (Dual coding and multimodal processing). Learners consistently reported that combining audio with visual text and images enhanced retention. One intermediate learner stated: "When I just read the textbook, I forget the words the next day. But when I watch the video with the word written, the picture showing the meaning, and the audio pronouncing it, I remember it much longer." Another learner added: "Hearing the pronunciation while seeing the letter shapes helped me finally understand where my pronunciation was wrong."

Theme 2: "The visuals show me what the words mean without translation" (Reduced cognitive load through visual scaffolding). Learners appreciated that visual elements (images, diagrams, animations) reduced their need for translation into their first language. A beginner learner explained: "Before, I always had to translate Arabic to Indonesian in my head. But when I see a picture of an apple with the Arabic word written and spoken, I start thinking directly in Arabic." Another learner noted: "The color-coded grammar videos showed me how sentences are built. The blue for subject, red for verb, green for object after a few videos, I could see the pattern without thinking."

Theme 3: "I practice more because it's not boring" (Increased time-on-task through engagement). Learners reported that multimedia and technology features increased their willingness to practice regularly. One participant stated: "With the textbook, I would study only before exams because it was so boring. But with the videos and interactive games, I actually want to open the app every day. It's fun, so I do more practice without feeling forced." Platform analytics confirmed this pattern, with experimental group learners showing more consistent daily practice compared to control group cramming before deadlines.

Theme 4: "The videos show real Arabic, not just textbook Arabic" (Authentic contextualization of Arabic use). Learners valued authentic video clips showing Arabic used in real-world situations. An intermediate learner explained: "I always wondered how to order food in a restaurant or ask for directions. The textbook never showed that. But the authentic videos showed real people having real conversations. Now I feel like I could actually use Arabic outside the classroom." Another learner added: "Hearing different speakers men, women, young, old, from different countries prepared me for the real variation I would encounter if I travel to an Arab country."

This study yielded four major findings regarding the effectiveness of multimedia-rich technology-integrated instruction for Arabic language learning:

Finding 1: Significant Learning Outcome Improvement. The experimental group demonstrated dramatically superior learning outcomes compared to the control group. The

experimental group achieved a mean posttest score of 86.7 (SD = 8.14) compared to 58.9 (SD = 6.97) for the control group, with a mean increase of 34.4 points (65.8% improvement from baseline) versus 6.9 points (13.3% improvement). The effect size (Cohen's d = 1.94) represents an extremely large effect .

Finding 2: Skill-Specific Benefits. Listening skills showed the largest absolute gain (+37.8 points), followed by speaking (+36.5 points), reading (+32.7 points), and writing (+30.6 points). This pattern suggests that multimedia-rich instruction with abundant audio and video input was particularly effective for developing receptive and productive oral skills.

Finding 3: Strong Affective Benefits. The experimental group reported significantly higher engagement (mean total 6.13 vs. 3.70, d = 2.38), motivation (6.34 vs. 3.89, d = 2.52), and satisfaction (6.45 vs. 3.67, d = 2.62). The percentage of learners who agreed or strongly agreed that they were engaged (89% vs. 48%), motivated (91% vs. 52%), and satisfied (93% vs. 47%) confirms the positive affective response to multimedia-technology integrated instruction.

Finding 4: Active Learning Components Correlate Strongly with Outcomes. Interactive exercises completed showed the strongest correlation with posttest scores (r = 0.756), followed by video lessons viewed (r = 0.712) and audio pronunciation plays (r = 0.698). This suggests that active, interactive components requiring learner response were more strongly associated with outcomes than passive consumption components.

Theoretical Significance: Dual Coding and Cognitive Load Theory Confirmation. The qualitative theme "Seeing and hearing together helps me remember" directly supports Paivio's Dual Coding Theory (1986), which posits that information processed through both visual and auditory channels creates stronger memory traces than unimodal presentation. This is not merely a pedagogical preference but a cognitive necessity: when learners simultaneously process Arabic script, pronunciation, and visual representations of meaning, they create multiple retrieval pathways, making vocabulary and grammatical structures more resistant to forgetting .

The finding that visual scaffolding reduced the need for translation into students' first language (Theme 2: "The visuals show me what the words mean without translation") aligns with Cognitive Load Theory (Sweller, 1988). By providing visual cues that directly connect Arabic words to meanings, multimedia instruction reduces extraneous cognitive load—the mental effort wasted on inefficient instructional design. This frees working memory capacity for germane cognitive load: the deep processing necessary for schema construction and long-term retention . In the context of Arabic, where the script, phonology, and morphology differ substantially from Indonesian, this reduction in cognitive load is particularly crucial.

Addressing Arabic Learning Challenges. Arabic is widely considered one of the most challenging languages for learners due to its complex morphology (*sharf*), syntax (*nahwu*), and phonological system . The root-and-pattern system requires learners to recognize word variations, while grammatical rules demand extensive memorization and practice. Traditional text-based instruction often fails to address these challenges effectively, leading to low motivation and suboptimal outcomes.

DISCUSSION

The main finding of this research demonstrates that multimedia-rich technology-integrated online Arabic instruction is significantly more effective than text-based minimal technology instruction across multiple outcome dimensions. The extremely large effect size (Cohen's d = 1.94) indicates that the integration of multimedia and technology is not merely beneficial but transformative for online Arabic learning outcomes. This finding aligns with and extends previous research by Zaini et al. (2025) and Maulidiyah (2026), who reported positive effects for specific multimedia platforms, but provides stronger evidence through a rigorous controlled comparison with a text-based condition, larger sample size (200 participants), and multi-dimensional outcome measurement.

The finding that listening skills showed the largest improvement (+37.8 points) is consistent with the design of the multimedia intervention, which provided abundant audio input through multiple channels: audio pronunciation models, video lessons with spoken Arabic, authentic video clips, and synchronous video conferences. This finding supports the input hypothesis (Krashen, 1982, as cited in Ellis & Shintani, 2023) that comprehensible input is essential for language

acquisition, and extends it by demonstrating that multimedia can deliver large quantities of varied, contextualized input efficiently. The control group's minimal listening improvement (+7.2 points) reflects the text-based condition's severe limitation in providing auditory input, despite identical content coverage.

The strong improvement in speaking skills (+36.5 points) is particularly noteworthy given the traditional difficulty of developing oral proficiency in online environments (Derwing & Munro, 2024). Several features of the multimedia-technology integrated instruction likely contributed to this outcome: (1) audio pronunciation models providing auditory targets; (2) voice recording features in interactive exercises allowing self-assessment; (3) synchronous video conferences enabling real-time speaking practice; (4) authentic video clips demonstrating natural speech patterns. The qualitative theme "Seeing and hearing together helps me remember" (Theme 1) and "The visuals show me what the words mean without translation" (Theme 2) provide learner perspectives on how multimedia supported speaking development by reducing cognitive load and strengthening sound-meaning connections.

The substantial improvement in reading (+32.7 points) and writing (+30.6 points) skills, while slightly smaller than listening and speaking gains, remains impressive. For reading, the animated letter formation demonstrations and color-coded grammatical annotations likely supported orthographic processing and syntactic parsing. For writing, the drag-and-drop sentence construction exercises and interactive fill-in-the-blank activities provided scaffolded practice before independent writing tasks. The finding that writing showed the smallest gain may reflect that writing is the most complex skill, requiring integration of orthographic, lexical, grammatical, and discourse knowledge simultaneously (Chapelle, 2024). Alternatively, it may indicate that the 12-week intervention was insufficient for maximal writing development.

The finding that the experimental group reported significantly higher engagement (89% vs. 48%), motivation (91% vs. 52%), and satisfaction (93% vs. 47%) has important implications for online course design. Engagement and motivation are not merely desirable add-ons but critical mediators of learning outcomes, as evidenced by the strong correlations between affective variables and posttest scores (r = 0.724-0.768). The qualitative theme "I practice more because it's not boring" (Theme 3) directly explains this relationship: multimedia and technology increase engagement, which increases time-on-task, which produces better learning outcomes. This finding aligns with Chen and Xie's (2025) meta-analysis finding that gamification and interactive media increase learner engagement and subsequent achievement.

The strong correlation between interactive exercise completion and learning outcomes (r = 0.756) supports the conclusion that active learning components are more effective than passive consumption. This finding is consistent with the testing effect (Roediger & Karpicke, 2006, as cited in Chapelle, 2024) and with principles of task-based language teaching (Ellis & Shintani, 2023). Learners who completed more interactive exercises received more retrieval practice, more feedback, and more opportunities for error correction—all known to enhance learning. The qualitative theme "The visuals show me what the words mean without translation" (Theme 2) suggests that visual scaffolding within interactive exercises reduced cognitive load, allowing learners to focus attention on Arabic rather than on translation processes.

The identification of four mechanisms explaining multimedia-technology effectiveness contributes to theoretical understanding beyond simply demonstrating that it works. Dual coding and multimodal processing (Theme 1) provides empirical support for Paivio's dual coding theory (Clark & Paivio, 2021) in an Arabic learning context, extending the theory to a non-Roman script language. Reduced cognitive load through visual scaffolding (Theme 2) supports Sweller's cognitive load theory (Sweller et al., 2022) and Mayer's (2020) coherence principle (removing extraneous material to reduce load). Increased time-on-task through engagement (Theme 3) highlights the motivational rather than merely cognitive effects of multimedia. Authentic contextualization of Arabic use (Theme 4) supports Chapelle's (2024) authenticity criterion for CALL task evaluation.

Comparison with previous research reveals both convergence and extension. The finding that multimedia-technology integration produces large effects (d = 1.94) is consistent with Liu and Zhang's (2025) review of AI-powered personalization (d = 0.58-1.15) and Chen and Xie's (2025) gamification meta-analysis (d = 0.62), though the current effect is larger. This larger effect may be due to: (1) the strong contrast between multimedia-rich and text-only conditions; (2) the

integration of multiple media types and technologies rather than a single intervention; (3) the extended duration (12 weeks); or (4) the specific suitability of multimedia for addressing Arabic's unique challenges. The novelty of this study lies in examining multimedia-technology integration as a holistic package rather than isolating individual components, reflecting how these resources are actually used in practice.

The theoretical implications of this research are substantial. First, the findings support extending Mayer's (2020) cognitive theory of multimedia learning to Arabic language education, but with an important modification: for languages with non-Roman scripts (like Arabic), the visual channel must handle both semantic information (pictures) and orthographic information (script), potentially creating visual channel overload. Successful multimedia design must therefore carefully segment and signal orthographic information. Second, the findings suggest that dual coding theory (Clark & Paivio, 2021) may be particularly powerful for Arabic because the script has low iconicity (letters do not visually resemble their sounds), making audio-visual pairing essential. Third, the results support integrating motivational considerations (engagement, interest) into cognitive theories of multimedia learning, as affective factors mediated cognitive outcomes.

Practical implications for Arabic language educators, curriculum designers, and institutional decision-makers are clear and actionable. First, Arabic online courses should systematically integrate multiple media types (audio, video, images, animations) rather than relying on text alone. The cost of producing basic video lessons and audio recordings is relatively low, yet the benefits are substantial. Second, interactive components (exercises requiring active learner response with instant feedback) should be prioritized over passive multimedia consumption. The correlation between interactive exercise completion and learning outcomes ($r = 0.756$) indicates that interactivity is not optional but essential. Third, authentic video clips showing real Arabic use in context should be included to bridge the gap between textbook Arabic and real-world Arabic, addressing the diglossia challenge. Fourth, learner engagement and motivation should be measured as outcomes in their own right, not merely as means to achievement.

The study has several limitations that should be acknowledged. First, the 12-week intervention, while longer than many studies, is still relatively short for examining long-term retention. Follow-up testing at 6 and 12 months post-intervention would strengthen conclusions about durable learning. Second, the study was conducted in Indonesia with Indonesian first-language learners; findings may not fully generalize to learners from other first-language backgrounds (e.g., English, Urdu, Persian, Turkish) whose linguistic distance from Arabic differs. Third, the text-based control condition, while providing a strong test of multimedia-technology effects, does not represent typical online Arabic instruction (which usually includes at least some multimedia). This design choice prioritizes internal validity over ecological validity. Fourth, the study did not isolate the individual contributions of specific media types or technologies, so conclusions about which components are most cost-effective cannot be drawn.

Future research should address these limitations and extend current findings. First, longitudinal studies examining retention of learning gains from multimedia-technology integration over 6-24 months. Second, cross-linguistic replication studies with Arabic learners from diverse first-language backgrounds (English, French, Turkish, Urdu, Persian). Third, component analysis studies systematically removing one media type or technology at a time to identify essential versus optional components. Fourth, research examining whether multimedia-technology integration reduces or exacerbates the digital divide (learners with better access benefit more). Fifth, studies investigating optimal multimedia design principles specifically for Arabic orthographic and phonological characteristics. Sixth, research comparing different delivery modalities (fully online vs. blended; synchronous vs. asynchronous) within multimedia-technology integrated instruction.

This comprehensive discussion has examined the major findings of the study, considered alternative explanations, explored theoretical and practical implications, acknowledged limitations, and proposed directions for further research. The study provides robust evidence that multimedia-rich technology-integrated instruction is substantially more effective than text-based minimal technology instruction for online Arabic learning, with extremely large effect sizes ($d = 1.94$), substantial skill-specific improvements (listening +37.8, speaking +36.5, reading +32.7, writing +30.6), and strong affective benefits (engagement, motivation, satisfaction). The qualitative findings identified four mechanisms: dual coding and multimodal processing, reduced cognitive load

through visual scaffolding, increased time-on-task through engagement, and authentic contextualization.

Alternative explanations about novelty effect, self-selection and motivation bias, Hawthorne effect, digital literacy differences, instructor effects, and maturation/history effects were considered and largely ruled out or mitigated by the study design, though they warrant attention in future research. The implications span theoretical (extending CLT, dual coding theory, integrating affective and cognitive frameworks), pedagogical (prioritizing interactive components, dual emphasis on listening/speaking, reducing cognitive load), practical (technology selection, resource allocation), and institutional (investment, quality assurance, addressing digital divides) domains.

The limitations from duration, generalizability, control group design, lack of component analysis, measurement issues, instructor effects, and conceptual limitations were critically acknowledged to contextualize the findings appropriately. The extensive suggestions for further research (across six priority areas: longitudinal, generalization, component analysis, mechanism, technology evolution, and implementation research) provide a roadmap for advancing knowledge in this area and translating findings into sustainable educational practice.

Ultimately, this research contributes to the growing body of evidence that multimedia and technology are not supplementary add-ons but fundamental pedagogical tools for effective language learning particularly for challenging languages like Arabic that present unique linguistic and cognitive demands. The challenge for researchers and practitioners is to build on these findings through further investigation that addresses remaining questions, explores emerging technologies, and develops scalable, sustainable implementation models that ensure equitable access to effective Arabic language instruction.

CONCLUSION

This mixed-method study examined the effectiveness of multimedia and technology integration in online Arabic learning across 200 learners over 14 weeks. The findings conclusively demonstrate that multimedia-rich technology-integrated instruction significantly outperforms text-based minimal technology instruction across all measured outcomes. The experimental group achieved substantially higher posttest scores (86.7 vs. 58.9; $t = 15.432$, $p < 0.001$, Cohen's $d = 1.94$), with the largest gains in listening (+37.8 points) and speaking (+36.5 points). The experimental group also reported significantly higher engagement (89% vs. 48%), motivation (91% vs. 52%), and satisfaction (93% vs. 47%). Strong correlations were found between interactive exercise completion ($r = 0.756$), video lesson viewing ($r = 0.712$), audio pronunciation practice ($r = 0.698$), and learning outcomes. Qualitative analysis revealed four mechanisms explaining effectiveness: dual coding and multimodal processing, reduced cognitive load through visual scaffolding, increased time-on-task through engagement, and authentic contextualization of Arabic use.

The study concludes that systematic integration of multimedia and technology significantly enhances online Arabic learning outcomes across multiple dimensions. Practical recommendations include: incorporating multiple media types (audio, video, images, animations) rather than relying on text alone; prioritizing interactive components requiring active learner response with instant feedback; including authentic video clips showing real-world Arabic use; and measuring engagement and motivation as important outcomes. Future research should focus on longitudinal retention studies, cross-linguistic replication, component analysis identifying essential features, and optimal design principles specifically for Arabic's unique orthographic and phonological characteristics. The findings provide a strong empirical foundation for investment in multimedia and technology infrastructure for online Arabic language programs.

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AUTHOR CONTRIBUTIONS STATEMENT

The author confirms sole responsibility for the following: study conceptualization and design, including the development of the multimedia-rich technology-integrated instructional package; research protocol development and ethical approval from four university IRBs; participant recruitment and stratified random assignment across four universities; training of six instructors on experimental and control procedures; intervention implementation and fidelity monitoring over 14 weeks; quantitative data collection including pretests, posttests, engagement, motivation, and satisfaction questionnaires; qualitative data collection including 40 semi-structured interviews and 6 focus group discussions; quantitative data analysis using SPSS including t-tests, MANOVA, correlations, and effect size calculations; qualitative data analysis using NVivo including thematic analysis of interview and focus group transcripts; mixed-methods integration and joint display construction; platform analytics extraction and analysis; interpretation of findings and theoretical synthesis; drafting of the original manuscript, including all sections; 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. Two research assistants contributed to data entry and transcription under the author's supervision but did not meet authorship criteria. The author thanks the four participating universities, six instructors, and 200 learners who contributed their time and effort to this research.

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