



Implementing Brain-Based Learning in Arabic Language Teaching: Pedagogical Practices and Challenges

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A B S T R A C T

Arabic language learning in Indonesia still faces multiple challenges: low communicative competence, high language anxiety, and weak mastery of morphosyntax, some of which stem from the dominance of conventional teacher-centered and grammar-translation methods. Although academic interest in Brain-Based Learning (BBL) has increased since 2020 and has been applied to non-Arabic foreign languages, science, and design, a literature review for this study has not yet identified any publications that map the twelve principles of BBL to the distinctive linguistic characteristics of the Arabic language while integrating them into Jensen's three-phase model. Based on this gap, this study aims to analyze the conceptual relevance of the twelve BBL principles to Arabic language acquisition, explore their implementation through Jensen's three-phase model, and critically reflect on their potential contributions and challenges. The study employs a library research approach in the form of a narrative-thematic review, with sources collected through a purposive-iterative process from Google Scholar, Scopus, ERIC, and ResearchGate based on eligibility criteria (indexed in Scopus/Sinta, published between 2021 and 2026, in English or Indonesian), resulting in a final corpus of 40 sources analyzed through thematic categorization, cross-study comparisons, and critical evaluation and synthesis. The results show that the twelve BBL principles can be conceptually mapped onto the linguistic features of the Arabic language and organized into Jensen's three-phase sequence, while also identifying the strengths and challenges of their application in madrasahs and pesantren; this mapping reflects a literature-based conceptual fit rather than empirically tested effectiveness, as the study did not involve any interventions or experiments. Its main contribution is conceptual: an adaptive pedagogical framework that links neuroeducation principles with the linguistic demands of the Arabic language, while opening up an agenda for further empirical research and practical directions for teacher training and neuroscience-based Arabic language learning policies.

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1. Introduction

The Arabic language occupies a highly strategic position in both the global and national educational landscapes, not merely because of its status as one of the six official languages of the United Nations, but also because of its irreplaceable role as the language of the Qur'an, the Prophet's hadith, and the classical Islamic intellectual tradition spanning more than fourteen centuries. In Indonesia, the country with the world's largest Muslim population, proficiency in Arabic is not merely an academic skill but a fundamental religious and cultural necessity for millions of students pursuing their education in madrasahs, pesantren, and Islamic universities (Hanani & Ahid, 2024). Data from the Ministry of Religious Affairs of the Republic of Indonesia indicates that there are more than 26,000 madrasahs and

approximately 36,000 pesantren that include Arabic as a core subject, making Indonesia one of the countries with the largest number of Arabic language learners in the world outside the Arab world (Sopian et al., 2025). This reality makes the quality of Arabic language instruction a strategic issue with far-reaching implications, both for the development of Islamic education and for the ability of Indonesia's Muslim generation to directly access sources of Islamic knowledge.

Various empirical studies consistently report that Arabic language learning in Indonesia still faces complex and multifaceted challenges. Low levels of students' communicative competence, high levels of Arabic anxiety, and weak mastery of Arabic morphosyntactic rules are problems repeatedly reported by researchers (Hanani & Ahid, 2024). Most high school graduates from Islamic schools are still unable to communicate actively in Arabic despite having studied it for years, and the ability to read Arabic text without vowel marks (*gundul*) remains a difficulty even for students at Islamic universities (Sopian et al., 2025). This recurring pattern indicates that the problem is not solely related to the curriculum or teaching materials but also to the pedagogical approaches applied in the daily learning process.

Part of the root of this problem is attributed to the dominance of conventional, teacher-centered teaching methods that rely on rote memorization and rigidly adhere to the grammar-translation method. This method has strong historical roots in the pesantren tradition; however, a number of studies in educational neuroscience indicate that the practice of memorizing vocabulary out of context, translating artificial sentences, and completing isolated grammar exercises tends to be less effective in engaging broader and more integrated language processing networks—which are believed to be relevant to authentic language acquisition (Jeong et al., 2021). Such an approach also tends to leave limited room for emotional, sensory, and social factors in learning; several studies in affective neuroscience show that these three factors contribute to meaningful and lasting learning (Immordino-yang et al., 2019; Winantaka et al., 2024). It should be noted that the educational neuroscience literature also cautions against overgeneralizing such findings into deterministic claims about “how the brain works” without considering the context and methodological limitations of the original studies (Gola et al., 2022). Therefore, the limitations of conventional approaches in this study are understood as issues that are supported by—rather than absolutely proven by—the available neuroscience findings.

It is within this framework that Brain-Based Learning (BBL) has emerged as a pedagogical paradigm argued to be more aligned with the biological functioning of the human brain. BBL was first conceptualized by Hart (1975) and subsequently developed into a more systematic theoretical framework by a number of experts in educational neuroscience, including Caine & Caine (2006), Jensen, E., & McConchie (2020), and Sousa (2024). This paradigm is based on the premise that the effectiveness of learning is determined in part by the extent to which instructional strategies take into account the principles of how the brain processes, encodes, stores, and retrieves information. One of the conceptual foundations of BBL is neuroplasticity—the brain's capacity to reorganize its neural connections in response to learning experiences; this capacity is noted to be influenced by emotional engagement, the richness of sensory input, and the quality of the learning environment (Jensen, E., & McConchie, 2020; Sousa, 2024). A recent bibliometric analysis of

literature indexed in Scopus and Web of Science indicates a rise in academic interest in BBL since 2020, while also noting that this field remains in a stage of theoretical consolidation, with fundamental debates regarding the legitimacy and limits of neuroeducation's application—including caution regarding a number of neuromyths circulating among educators (Santiago et al., 2026).

The relevance of BBL to Arabic language learning becomes even more evident when considering contemporary research findings on how the human brain acquires language. Research in the fields of neurolinguistics and psycholinguistics shows that effective language acquisition involves the simultaneous activation of various brain regions that handle semantic, phonetic, pragmatic, and emotional processing in an integrated manner (Teng & Teng, 2022; Elmer et al., 2019). Studies on brain imaging relevant to the science of reading Arabic also confirm the involvement of complex neural networks in the processing of Arabic script (. These findings are relevant to the unique challenges of learning Arabic, which features a right-to-left writing system, a phoneme inventory not found in European languages or Indonesian (such as the phonemes *ain*, *ghain*, *kha*, and *pharyngeal ha*), a highly productive morphological system based on triliteral word roots (*wazan*), and a formal register (*fusha*) that differs significantly from vernacular dialects (*'ammiyyah*). This linguistic complexity conceptually demands an instructional approach capable of engaging various brain processing modalities simultaneously, rather than relying solely on cognitive-analytic pathways.

Empirical studies on BBL published over the past five years present a more diverse and not always consistent picture than is often implied in the literature supporting BBL. In the field of language education, a number of small-scale quasi-experimental studies have reported positive but partial results. Iranmanesh et al., (2022) found an improvement in English speaking skills among medical students in Iran after one semester of BBL intervention, but this study involved only one institution and did not control for participants' extrinsic motivation. Wilson et al., (2023), through a qualitative study of ESL teachers in Malaysia, reported generally positive perceptions and practices regarding BBL; however, its application was limited to the English literature component for low-proficiency learners and did not address language skills comprehensively. Meanwhile, Arun & Singaravelu, 2021, in the context of EFL in Iran, found that BBL-based vocabulary teaching strategies significantly improved vocabulary retention but had no significant effect on recall ability—a finding that actually suggests that the effects of BBL are not always consistent across language subskills. This pattern of mixed results indicates that claims of BBL's success in language education should be interpreted contextually and conditionally, rather than generalized as a single, uniform effect.

Different patterns were found in BBL studies in non-language domains. In science education, the implementation of BBL was reported to be associated with improved science literacy at the elementary school level (Esplendori & Kobayashi, 2022) as well as the strengthening of higher-order thinking skills in science learning at the secondary level (Wang & Zeng, 2022). In the fields of design and fine arts, a bibliometric study by Zhou, (2024) of 186 Scopus-indexed publications found that the application of BBL tends to address only six of the twelve BBL principles considered relevant to the stages of creativity, and in fact shows a declining trend in research interest over the past two decades. These findings in

the fields of science and design are important as supporting evidence for the conceptual feasibility of BBL across disciplines, but they cannot be directly transferred to Arabic language learning. The processing of scientific and visual design concepts involves cognitive demands that are substantially different – particularly in the conceptual-spatial dimension – compared to language processing, which requires the simultaneous integration of phonological, morphosyntactic, semantic, and pragmatic pathways (Teng & Teng, 2022; Elmer et al., 2021). Thus, generalizing BBL findings from non-linguistic domains to Arabic language learning requires methodological and conceptual caution, which—as far as the literature reviewed in this study is concerned—has not yet been explicitly addressed to a significant extent.

Specifically in the context of the Arabic language, the implementation of BBL remains very limited in scope and is only partial. (Yolanda et al., 2024) developed an augmented reality-based Arabic language learning medium that adapts some of the BBL principles; however, their study focused on media product development and has not yet integrated all twelve BBL principles into a comprehensive pedagogical framework, nor has it systematically considered the morphosyntactic characteristics of the Arabic language. On the other hand, Hanada Taha Thomure, (2023) reviewed brain imaging findings relevant to Arabic reading instruction; however, this review was descriptive in nature regarding the science of reading and was not designed as a BBL instructional framework ready for classroom implementation. Based on a review of the literature included in this study, no publication has been found that explicitly maps the twelve BBL principles to the linguistic characteristics of the Arabic language while operationalizing them within Jensen's three-phase instructional model (pre-exposure, focused acquisition, and elaboration). This gap statement is explicitly limited to the scope of the literature reviewed in this study and is not intended as an absolute claim regarding the absence of broader efforts in the field.

Based on the gaps identified above, the novelty of this study is specifically defined as follows: This study offers a conceptual synthesis that systematically maps the twelve principles of BBL onto the linguistic characteristics of the Arabic language including the right-to-left writing system, the inventory of pharyngeal phonemes, trilateral root morphology, and the fusha-'ammiyyah diglossia while integrating them into Jensen's three-phase instructional model. The primary intellectual contribution of this study is therefore not merely the application of existing BBL concepts to a new context, but rather an adapted pedagogical framework that structurally links neuroeducational principles with the specific linguistic demands of the Arabic language—a mapping that, to the best of the reviewed literature, has not yet been explicitly available in the field of Arabic language education.

Given these gaps and new developments, this study aims to: (1) analyze the twelve principles of BBL and their conceptual relevance to the process of Arabic language acquisition, taking into account the linguistic characteristics and sociocultural context of Arabic language learning in Indonesia; (2) explore the possibility of implementing BBL in Arabic language classrooms through its integration with Jensen's three-phase teaching model; and (3) conduct a critical reflection on the potential contributions as well as the challenges of applying BBL in real-world Arabic language learning contexts, including the limitations of currently available empirical evidence. Thus, this study is expected to provide a conceptual foundation for the development of neuroscience-based Arabic language

pedagogy, as well as to open the door for further empirical research to systematically test the theoretical propositions generated across various educational levels and contexts.

2. Methods

2.1. Research Design

This study employs a library research approach, specifically a narrative-thematic literature review. This approach was chosen because the purpose of this study is to produce a comprehensive theoretical synthesis regarding the application of Brain-Based Learning (BBL) in Arabic language learning (Sousa, 2024), rather than to report new empirical data from the field. This study employs a purposive and iterative search strategy to identify primary sources from the fields of cognitive neuroscience, education, and applied linguistics, in order to identify the fundamental principles of BBL and their relevance to Arabic language learning practices (Jensen, E., & McConchie, 2020).

2.2. Information Sources and Search Strategies

Data sources were obtained from academic databases, namely Google Scholar, Scopus, ERIC, and ResearchGate. Google Scholar, Scopus, and ERIC were selected for their broad coverage of literature on education and neuroscience; ResearchGate was retained as a supplementary source for accessing manuscripts that are also indexed or validated through other academic databases, rather than as a standalone primary source. Searches used the following keywords: brain-based learning, Arabic language teaching, neuroscience education, language acquisition, active learning Arabic, along with combinations using Boolean operators (AND/OR), such as “brain-based learning” AND “Arabic language teaching,” or “neuroscience education” AND “language acquisition.” The search was limited to sources in English and Indonesian.

2.3. Eligibility and Selection Criteria for the Study

The selection of sources for this study used eligibility criteria based on thematic relevance. Inclusion criteria include: (1) journal articles indexed in Scopus/Sinta or other academic sources that have undergone a peer-review process; (2) publications discussing the principles of BBL, educational neuroscience, language acquisition, or Arabic language pedagogy, whether in the form of theoretical studies, empirical research, or practical applications; (3) publications from the last Seven years (2019–2026) are prioritized, with the exception of foundational theoretical works that remain primary references for a concept even if published earlier (e.g., Caine & Caine, 2006); and (4) those written in English or Indonesian. Exclusion criteria include: (1) sources that have not undergone peer review and lack verifiable academic credibility (e.g., non-academic blogs); (2) duplicate sources in more than one database; (3) sources whose full text is not accessible; and (4) sources whose topics are not relevant to BBL, educational neuroscience, or language learning after reviewing the title and abstract. This study does not report the number of records initially identified, screened, and excluded at each stage of the screening process in a flow diagram. The final corpus actually referenced and synthesized in this study consists of 40 sources, the composition of which—including the proportions of theoretical sources, empirical sources in non-Arabic foreign language contexts, and sources specifically discussing the Arabic language—is characterized in Section 3.1.1.

2.4. Data Extraction and Coding

From each source that met the eligibility criteria, the following information was extracted and recorded in a structured manner: (1) the BBL principles or themes discussed; (2) the type and design of the study (theoretical/conceptual, quasi-experimental, qualitative, bibliometric, and similar); (3) the research context (target language, educational level, country/region); (4) key findings; and (5) the strengths and limitations reported or identifiable from the study. These extraction categories form the basis for the mapping presented in Table 1, Table 2, and Table 3 in the Results section, with each principle, phase, or claim explicitly linked to its supporting literature. The extraction and coding process was conducted by the authors through iterative reading and cross-checking against the original sources to ensure consistency in categorization across sources.

2.5. Data Analysis and Synthesis

Data analysis in this study employed content analysis, which consisted of three stages. The first stage was thematic categorization, which involved classifying the literature into themes relevant to BBL and Arabic language learning, as reflected in the twelve principles of BBL and the three phases of Jensen's model in Table 1 and Table 2. The second stage involved cross-study comparison, which entailed identifying patterns of consistent findings (convergence) as well as differing perspectives (divergence) among the studies reviewed, as explicitly reported in Section 3.1.5. When conflicting findings were identified across sources, this study explicitly reported both sides of the findings along with possible explanations (e.g., differences in language context, skills measured, or study design), rather than selecting one side without explanation.

The third stage, critical evaluation and synthesis, involves evaluating the strengths and limitations of applying BBL in the context of Arabic language learning, and then synthesizing these findings into a conceptual framework that links BBL principles to the linguistic characteristics of Arabic and Jensen's instructional model. Since this study was conducted by the author individually, a consistency check was performed through gradual re-reading and verifying that each synthesis claim corresponded to the original source citation.

3. Results

3.1. Characteristics of the Reviewed Literature

This synthesis draws on 40 sources cited throughout the text, encompassing both theoretical/conceptual works and empirical studies published primarily between 2019 and 2026, with the majority published in the last five years. Approximately one-quarter of the corpus ($n = 10$) consists of theoretical or meta-level works that describe the architecture of BBL itself or synthesize the current state of the field through bibliometric methods or scoping reviews, including Hart (1975), Caine & Caine (2006), (Immordino-yang et al., 2019), Bignetti, (2018), Tokuhama-espinosa & Ali Nouri (2020), Jensen, E., & McConchie (2020), Immordino-yang & Damasio (2007), Sousa (2024), Ginting & Tungka, (2025), and (Gola et al., 2022)

The remaining sources are empirical. Of these, about ten sources discuss brain-based learning or neuroscience-based learning in the context of English or other foreign languages outside the context of Arabic, including quasi-experimental studies and meta-analyses by Iranmanesh et al. (2022), Wilson et al., (2023), Santiago et al., (2026), Abdolmaleki & Saeedi (2024), Çelik & Ersanlı (2022), Teng 2023), (Elmer et al., 2021), and Funa & Jetomo (2024). A

smaller group, consisting of six to seven sources, specifically addresses Arabic language learning Hanani & Ahid (2024), Sopian et al., (2025), Annisa et al. (2024), Alfatih et al (2025), and Solahudeen et al., (2022) but these sources primarily document students' anxiety, speaking confidence, or general pedagogical issues, rather than testing the BBL framework itself.

Only two sources in the corpus explicitly combine BBL and Arabic language learning: Yolanda et al., (2024), who tested an augmented reality-based BBL medium, and Hanada Taha Thomure (2023), who reviewed brain imaging evidence relevant to reading Arabic. Neither reports controlled empirical testing of the twelve-principle framework integrated with Jensen's model in Arabic language classrooms. The other eight sources discuss educational technology and digital learning more broadly (e.g., Wiboolyasarin & Jinowat, 2023; Sahlan, 2023; Hamad et al., 2024; Dwiputra et al., 2023) and three sources discuss BBL in non-language disciplines, which were included for cross-domain comparison in the Introduction section (Wang & Zeng, 2022; Iranmanesh et al., 2022). With this composition, the corpus supports a conceptual synthesis of BBL principles and their potential relevance to Arabic language pedagogy; however, it does not provide direct empirical evidence of the effectiveness of the integrated framework proposed in this study—a limitation explicitly stated in Section 3.2.8.

3.2. Principles of Brain-Based Learning in Arabic Language Instruction

Brain-Based Learning (BBL) is grounded in twelve closely interrelated principles that form the conceptual foundation for the framework proposed in this study. Table 1 presents each principle, its main idea, proposed applications in Arabic language instruction, and the specific literature on which the mapping is based. The last column distinguishes sources that report empirical findings from those that provide only theoretical rationales, thereby making the evidential status of each row transparent.

Table 1. Principles of Brain-Based Learning in Arabic Language Instruction

Principles	Key Concepts	Implementation in Arabic Language Instruction	Representative Literature
Principle 1: Parallel Processing	The brain processes cognitive, emotional, and sensory stimuli simultaneously.	Integrating visual elements (Hijaiyah letter cards, Nahwu diagrams), auditory input (recordings of native speakers), and kinesthetic activities (calligraphy exercises, role-playing conversations).	(Sousa, 2024) - theoretical; (Elmer et al., 2021) - Immordino-ying et al., 2019) empirical, general language processing (not specific to Arabic)
Principle 2: Emotional Engagement	Emotions strengthen memory, motivation, and retention.	Use stories from Islamic tradition, humor, collaborative group work, and cultural exchange with Arab cultures to foster emotional engagement.	- theoretical; Annisa et al., 2024- empirical, anxiety related to speaking Arabic (Indonesian)
Principle 3: Experiential Learning	Learning through real-life experiences strengthens neural connections.	Role-playing everyday conversations in Arabic, group discussions, and the use of multimedia (Arabic-language lecture videos, podcasts, Arabic songs).	Şeyma Şahin et al., (2023)- empirical, general foreign language context (not specific to Arabic); Caine & Caine (2006) - theoretical
Principle 4: Pattern	The brain recognizes recurring structures	Teach wazan patterns (Arabic morphology), nahwu-sharaf	Jensen, E., & McConchie, (2020) - theoretical; Teng,

Principles	Key Concepts	Implementation in Arabic Language Instruction	Representative Literature
Recognition	to reinforce understanding.	grammar, and phonetic patterns; repeat structures in various contexts.	2023) – empirical, general foreign language context (not specific to Arabic)
Principle 5: Active Processing	Active engagement deepens learning.	Language analysis, solving Arabic language puzzles, creative writing in Arabic, self-reflection activities.	Jensen, E., & McConchie, 2020 – theoretical
Principle 6: Multisensory Input	Engaging multiple senses strengthens neural connections.	Use images, Arabic songs, podcasts, movement-based games, and tactile materials (Hijaiyah letter boards).	Sousa (2024) – theoretical; Yolanda et al. (2024) – empirical, Arabic + augmented reality (partial implementation)
Principle 7: An Enriched Environment	A rich emotional and intellectual atmosphere enhances learning.	Color-coded materials for vowel marks (harakat), music, a dynamic classroom layout, a reading corner, and an Arabic-themed sensory zone.	Immordino-ying & Damasio (2007) – theoretical
Principle 8: Relaxed Alertness	A balance between challenge and comfort optimizes learning.	Scaffolding tasks, fostering a growth mindset, accepting mistakes as part of the learning process, and creating an emotionally safe classroom environment.	Sari et al., (2024) – empirical, anxiety about speaking Arabic (Indonesian); Caine & Caine (2006) – theoretical
Principle 9: Social Interaction	Social learning enhances understanding and memory.	Simple debates in Arabic, peer review, cooperative problem-solving, and role-playing Arabic conversations.	Immordino-ying & Damasio (2007) – teoretis
Principle 10: Feedback and Reflection	Feedback and reflection strengthen metacognition.	Immediate feedback from the teacher, peer feedback, Arabic language learning journals, self-assessment.	Jensen & McConchie (2020) – teoretis
Principle 11: Intrinsic Motivation	Personal relevance enhances focus and memory.	Autonomy in learning, setting one's own vocabulary memorization goals, and linking personal interests to Arabic language tasks.	Abdolmaleki & Saeedi, (2024)– empirical study, general foreign language context (not specific to Arabic)
Principle 12: Real-World Application	Authentic practices reinforce learning.	Debates, presentations, writing letters or essays in Arabic, and problem-solving tasks in everyday contexts. Çelik &	Çelik & Ersanlı, (2022) – empirical, general foreign language context (not specific to Arabic); Sousa (2024) – theoretical

3.3. Jensen's Model for Implementing BBL in Arabic Language Classes

Jensen's three-phase instructional model provides a sequencing framework that allows the twelve BBL principles to be organized into classroom practice. Table 2 shows how these principles are distributed across the Pre-Learning, Active Learning, and Post-Learning phases, along with the literature underlying each phase and an indication of its evidence base. The neurobiological processes conventionally associated with each phase (e.g., cortisol regulation, prefrontal and limbic activation, hippocampal consolidation) are drawn from the general neuroscience of learning literature, rather than from studies conducted specifically on Arabic language learners; therefore, they are reported here as conceptual associations, not

as measurable results of this study; their interpretation is discussed in greater detail in the Discussion section below.

Table 2. Integration of the 12 BBL Principles into the Jensen Model for Arabic Language Learning

Jensen's Stages	BBL Principles Primary (Conceptual)		Brain Processes		Representative Literature (Evidence Base)
Pre-Learning Phase	Emotional engagement, motivation, optimal environment (Principles 2, 7, 8, 11)		Focusing attention, reducing stress, increasing relevance		Jensen, E., & McConchie, (2020); Sousa (2024)– theoretical only; no language-specific empirical studies on Arabic have been found
Pre-Learning Phase	Emotional engagement, motivation, optimal environment (Principles 2, 7, 8, 11)		Focusing attention, reducing stress, increasing relevance		Jensen, E., & McConchie, (2020); Sousa (2024) – theoretical only; no language-specific empirical studies on Arabic have been found
Post-Learning Phase	Reflection, application, real-world integration (Principles 5, 8, 12)		Consolidation, transfer, formation of long-term memory		Jensen, E., & McConchie, (2020) – purely theoretical; no language-specific empirical studies on Arabic have been found

3.4. Strengths and Challenges of BBL Implementation Reported in the Literature

In relation to the third research objective, Table 3 reports the strengths and challenges of BBL implementation identified from the reviewed literature, along with the specific sources underlying each entry. These strengths largely stem from theoretical and quasi-experimental sources that discuss BBL in a general context or in the context of foreign languages (e.g., Sousa, 2024; Abdolmaleki & Saeedi, 2024; Çelik & Ersanlı, 2022), while the challenges largely stem from sources addressing teacher readiness, infrastructure, and assessment conditions in madrasah and pesantren settings in Indonesia (e.g., Tokuhama-espinosa & Ali Nouri, 2020; Dwiputra et al., 2023; Bignetti, 2018). No source in the corpus reports these strengths and challenges as the results of empirical measurements in an Arabic-language BBL intervention; the entries below therefore represent literature-based expectations, not confirmed findings.

Table 3. Strengths and Challenges of BBL Implementation Reported in the Literature

Aspects	Deskriptions	Sources
Strengths	Enhances student engagement and motivation through multisensory activities. The integration of BBL into the formal curriculum still requires policy and institutional support.	Sousa (2024)
Strengths	Supports various learning styles (visual, auditory, kinesthetic).	Jensen, E., & McConchie, (2020)
Strengths	Creates a more emotionally safe learning environment, which has the potential to reduce student anxiety.	Abdolmaleki & Saeedi, (2024)
Strengths	Has the potential to strengthen vocabulary retention and grammar rules through experiential tasks that engage emotions.	Immordino-yang et al., (2019); Sari et al., (2024)
Strengths	Encouraging active and authentic Arabic language communication.	Çelik & Ersanlı, (2022)
Strengths	Fostering students' intrinsic motivation and autonomy.	Abdolmaleki & Saeedi, (2024)
Strengths	Requires teachers to have a working understanding of neuroscience	Tokuhama-espinosa

Aspects	Deskriptions	Sources
	and cognitive science, which are not yet integrated into most Arabic teacher training programs.	& Ali Nouri, (2020)
Challenges	Experiential learning-based lesson planning demands a significant amount of time, flexibility, and creativity, which is difficult to sustain in educational institutions with limited resources.	Dwiputra et al., (2023)
Challenges	Uneven availability of supporting materials and technology across schools and madrasahs.	Dwiputra et al., (2023)
Challenges	Classroom management becomes more complex when learning involves movement and active participation.	(Bignetti, 2018)
Challenges	There is a tension between experiential/applied learning and the tradition of standardized, rote-memorization-oriented assessment, which remains dominant in Arabic language evaluation in Indonesia.	Jensen, E., & McConchie, (2020)
Challenges	The integration of BBL into the formal curriculum still requires policy and institutional support.	Jensen, E., & McConchie, (2020)

3.5. Convergences, Divergences, and Limitations Across the Studies Reviewed

In line with the methodology outlined for this study, three patterns of convergence and divergence can be reported. First, sources discussing emotional and sensory engagement converge in linking positive affect and multisensory input to improved retention and motivation, regardless of the target language (Sousa, 2024; Immordino-yang & Damasio, 2007; Annisa et al., 2024; Sari et al., 2024); however, none of these sources report effect sizes specific to the Arabic language. Second, sources discussing pattern-based morphology converge on the general principle that explicit attention to repetitive structures supports retention (Jensen, E., & McConchie 2020; Teng, 2023), but none have directly tested this principle against the Arabic root-and-pattern (*wazan*) system. The application to Arabic morphology proposed in this study is therefore an extrapolation from the cross-linguistic pattern recognition literature, not a confirmed finding.

Third, sources hold divergent views regarding the magnitude of the BBL effect compared to conventional learning: a cross-disciplinary meta-analysis found a large average effect size for BBL, with no significant moderating differences between English and STEM disciplines (Funa et al., 2024), while a quasi-experimental study in a single context reported more moderate and sometimes skill-specific effects—for example, improved vocabulary retention without a corresponding improvement in recall ability (Arun & Singaravelu, 2021). This divergence suggests that the strength of BBL's effects is likely moderated by specific language skills and the measurement tools used—a consideration that has not yet been tested for Arabic. These patterns of convergence, divergence, and limitations in the evidence directly inform the interpretive discussion that follows.

4. Discussion

4.1. Summary of Key Findings in Relation to the Research Objectives

With regard to the first objective, the twelve BBL principles were mapped onto specific linguistic features of the Arabic language—namely, writing direction, pharyngeal phonemes, and root-based morphology—resulting in a principle-to-feature correspondence summarized in Table 1. Regarding the second objective, these principles were organized into Jensen's three-phase instructional sequence, resulting in a grade-level structure summarized in Table 2. Regarding the third objective, the strengths and challenges of implementing this

framework in the context of Arabic language learning in Indonesia were identified and summarized in Table 3. Across all three objectives, the findings synthesized here constitute a conceptual mapping grounded in the reviewed literature, rather than the result of an original empirical intervention. The discussion below interprets this mapping in relation to prior research and explicitly states where it confirms, extends, qualifies, or differs from that research.

4.2. Sensory-Emotional Integration and Orthographic-Phonological Challenges in Arabic

The convergence of Principles 1 (parallel processing), 6 (multisensory input), 2 (emotional engagement), 8 (relaxed alertness), and 11 (intrinsic motivation) regarding the orthographic and phonological demands of the Arabic language are generally consistent with previous findings that multisensory and emotionally engaging learning supports language retention (Sousa 2020; Immordino-yang et al., 2019). This extends the existing evidence—most of which was generated in English or other Latin-script languages (Elmer et al., 2021)—to a right-to-left writing system with harakat and pharyngeal consonants, features not found in Indonesian or most European languages. However, no source in the corpus has tested whether the same multisensory principles apply with equal strength to the specific orthographic demands of Arabic; therefore, this extension should be interpreted as a plausible hypothesis rather than a confirmed transfer.

Regarding learners' anxiety, this synthesis is consistent with Annisa et al., (2024) and Sari et al. (2024), who documented significant anxiety among Indonesian learners when confronted with unfamiliar Arabic language structures. Framing relaxed vigilance and intrinsic motivation as design principles for Arabic language instruction qualifies, rather than resolves, this evidence, as neither of these two sources evaluated BBL-specific interventions. The association proposed here should therefore be interpreted as a design implication drawn from the anxiety literature, rather than as a proven reduction in anxiety caused by BBL.

4.3. Cognition of Morphological Patterns and the Wazan System

Principles 4 (pattern recognition), 5 (active processing), and 10 (feedback and reflection) converge around one of the central features of the Arabic language: the highly productive and rule-based root-and-pattern (wazan) morphology. This is consistent with—and expands upon—the general finding that explicit engagement with repetitive structures supports language retention (Jensen, E., & McConchie, 2020; Teng, 2023), by proposing inductive wazan pattern discovery tasks as a concrete application of this principle. This proposal remains a theoretical extension rather than a tested intervention: no studies identified in this review have specifically evaluated inductive pattern recognition tasks for Arabic morphology; therefore, claims regarding their effectiveness for mastering wazan should be treated as hypotheses for future empirical testing, not as established findings.

4.4. Social-Experiential Authenticity and Its Implications for the Four Language Skills

Principles 3 (experiential learning), 7 (enriched environment), 9 (social interaction), and 12 (real-world application) converge around the value of authentic, socially grounded practice. This is generally consistent with evidence that authentic input enhances listening comprehension (Teng, 2023) and that social interaction supports language retention more broadly (Immordino-yang et al., 2019). Applied to the four Arabic language skills, the literature indicates that authentic listening input has the potential to support phonetic

discrimination (Teng, 2023), that psychologically safer environments have the potential to support oral production given the anxiety documented by Sari et al., (2024), that inductive exposure to morphological patterns has the potential to support reading development, and that meaningful writing tasks accompanied by iterative feedback have the potential to support writing proficiency (Sousa, 2024).

These statements are presented as reasonable implications consistent with the literature, not as proven effects, since none of the underlying sources tested outcomes specific to the Arabic language. Accordingly, previous formulations stating that BBL yields “significantly” greater outcomes or that vocabulary learned through emotional contexts is “far easier to remember” than through conventional memorization have been toned down in this revision: the available sources (Elmer et al., 2021; Teng, 2023) support a direct association between multisensory learning involving emotions and retention, but do not report measurable comparative effects specifically for the Arabic language.

4.5. Theoretical Contributions of the Proposed Framework

The theoretical contributions of this study lie specifically in the structured mapping presented in Table 1 and Table 2: a systematic correspondence between the twelve BBL principles, the distinctive linguistic characteristics of the Arabic language, and Jensen’s three-phase instructional sequence. This contribution is best characterized as a conceptual synthesis and an adapted pedagogical framework, rather than as a new learning theory or a validated instructional model. This study reorganizes the existing literature on BBL and Arabic language pedagogy into a form that can be tested in future empirical research; however, the mapping itself has not yet been empirically validated. This distinguishes this study from previous BBL-Arabic works such as (Yolanda et al., 2024), which applied some BBL elements to a single technology (augmented reality) without addressing the entire twelve-principle architecture, and from (Hanada Taha Thomure, 2023), whose contribution consisted of a review of brain imaging evidence rather than an instructional framework.

4.6. Institutional Strengths, Challenges, and Readiness

The strengths reported in Table 3—particularly increased engagement, support for diverse learning styles, and enhanced retention through experiential activities—are consistent with the broader BBL literature (Sousa, 2024; Abdolmaleki & Saeedi, 2024); however, as noted in Section 3.1.4, they have not yet been specifically measured in Arabic language classrooms. The identified challenges are substantial and, in the context of madrasahs and pesantren in Indonesia, appear to outweigh these strengths in terms of the feasibility of immediate implementation (Aulina et al., 2024). The requirement that teachers understand neuroscience and cognitive science is rarely addressed in current Arabic teacher training programs, which still emphasize classical linguistic disciplines such as nahwu, sharaf, and balaghah over neuroscience-based pedagogy (Tokuhamaspinosa & Ali Nouri, 2020).

Designing BBL-based learning also requires planning time, access to materials, and classroom flexibility—resources that madrasahs and pesantren with limited resources cannot always provide (Dwiputra et al., 2023). Classroom management is another consideration: implementing BBL activities that involve movement and active participation requires a clear management structure (Bignetti, 2018), and when these activities take the form of project-based work—such as collaborative Arabic-language video or podcast projects—they require

more careful facilitation than conventional lecture-based learning. Finally, BBL's emphasis on experiential and applied learning is at odds with the tradition of standardized, memorization-oriented assessment that remains dominant in Arabic language evaluation in Indonesia, including religious exams and admissions to Islamic universities; resolving this tension likely requires institutional and policy support (Jensen, E., & McConchie, 2020), rather than merely adaptation at the teacher level.

4.7. Digital Prospect of BBL in Arabic Language Learning in the Digital Age

Digital tools offer a viable pathway for extending certain BBL principles to Arabic language instruction, although the corpus of this study provides only indirect support for this claim, as none of the digital learning resources cited here specifically focus on the Arabic language. Existing language-learning apps have, in fact, already implemented design features consistent with BBL—gamification for emotional engagement, spaced repetition for memory consolidation, and multimodal input for parallel processing—generally without explicitly labeling them as BBL. Mobile and adaptive platforms have been reported to strengthen form-meaning associations and learner engagement in other language contexts (Wiboolyasarini & Jinowat, 2023; Anwar & Ahyarudin, 2023; Sabagh, 2021), and both blended and online formats are reported to maintain social interaction and engagement when intentionally adapted (Sahlan, 2023; Hamad et al., 2024). Whether these findings can be transferred to Arabic language instruction in Indonesian madrasahs and pesantren—which face their own limitations in infrastructure and connectivity—remains an open empirical question, not an established prospect, and in this study is treated as a direction for future research (Section 3.2.9), not as a current finding.

4.8. Limitations of the Study Implications and Directions for Future Research

This study has several limitations that should be noted in light of the conclusions above. First, this study is a literature-based conceptual synthesis; the selection of studies was not conducted through independent duplication, and no formal quality assessment of the included sources was performed. Second, as reported in Section 3.1.1, this corpus contains very few sources that specifically examine BBL in Arabic language instruction; consequently, most of the mapping of principles to Arabic in this study constitutes theoretical extrapolation rather than confirmation from primary data. Third, this corpus is skewed toward the context of English and other Latin-script foreign languages, which may not fully represent the specific cognitive and pedagogical demands of Arabic script, phonology, and morphology. Fourth, a number of the sources used are theoretical or narrative in nature (e.g., Caine & Caine, 2006; Bignetti, 2018), rather than empirical, thus limiting the strength of the causal claims that can be drawn from them. These limitations do not invalidate the conceptual synthesis offered here, but they underscore that the framework proposed in this study should be treated as a set of testable propositions, not as a validated pedagogical guide.

The limitations identified above directly point to specific research needs. Since this corpus does not yet include a controlled comparison between BBL and conventional instruction in Arabic language classes, future research should prioritize quasi-experimental or experimental designs that directly compare BBL-based Arabic instruction with grammar-translation-based instruction across all four language skills, following the general comparative approach used by Funa et al., (2024)) but specifically applied to Arabic and comparable foreign language contexts. Recent Scopus-indexed studies comparing Brain-

Based Learning with other language teaching approaches in Arabic or comparable foreign language contexts remain very limited; expanding this evidence base is a priority to determine whether the effect sizes reported in the general BBL meta-analysis (Funa et al., 2024) also apply to Arabic specifically.

Second, because the neurobiological mechanisms discussed in Section 3.1.3 are drawn from general neuroscience rather than from data specific to the Arabic language, longitudinal studies incorporating objective neurometric measures—such as eye-tracking or electroencephalography—will help determine whether these mechanisms function as proposed when learners encounter Arabic script and morphology (Jeong et al., 2021). Third, given the institutional and infrastructural challenges identified in Section 3.2.6, implementation studies conducted in real-world madrasah and pesantren settings in Indonesia are necessary to determine the practical feasibility of the proposed framework, rather than relying solely on conceptual arguments. These three directions, if pursued, will allow the theoretical framework proposed in this study to be empirically tested and directly address the evidence gap identified in Section 3.1.1.

5. Conclusion

This study presents a conceptual synthesis that maps twelve principles of Brain-Based Learning (BBL) to the linguistic characteristics of the Arabic language and integrates them into Jensen's three-phase instructional model (pre-learning, active learning, and post-learning). The primary contribution of this study is conceptual: it provides an adaptive pedagogical framework that systematically links neuroeducation principles with the specific linguistic demands of the Arabic language—a mapping that, to the best of the reviewed literature, has not yet been explicitly available in the field of Arabic language education. As a literature synthesis, this framework offers a conceptual foundation that is theoretically aligned with the principles of brain-based learning, rather than one whose effectiveness has been empirically proven in Arabic language classrooms.

It is argued that the implementation of this framework in Arabic language classrooms requires deliberate, neuroscience-based instructional planning, the availability of adequate resources, and alignment with more holistic assessment practices. As discussed in Section 3.2.6, this in turn requires teacher training that integrates educational neuroscience into the Arabic language training curriculum, as well as institutional and policy support for the piloting and gradual refinement of BBL-based learning practices in madrasahs and pesantren, rather than a comprehensive, all-at-once implementation.

This study has limitations that have been outlined in Section 3. 2.8, primarily because it is a literature-based conceptual synthesis without direct empirical validation in Arabic language classrooms, the limited availability of sources addressing variations in student groups (e.g., multilingual or students with special needs), and the scarcity of discussion regarding assessment practices and external barriers to the implementation of BBL in Indonesian madrasahs and pesantren. As detailed in Section 3.2.8, these limitations directly inform the agenda for future research, namely the empirical testing of this framework across various levels of Arabic language proficiency, the evaluation of its long-term impact, its adaptation for post-pandemic online and hybrid learning environments, and the development of BBL-based assessment instruments appropriate for the context of Islamic education in Indonesia.

Overall, this study contributes to the development of neuroscience-informed Arabic language pedagogy by providing a conceptual framework that can serve as a starting point for further empirical research, without intending to make any claims regarding the empirical validity of its application.

Declarations

Author Contribution Statement

Hasan Syukur designed the study, conducted the literature review and analysis, and prepared the initial draft of the article. M. Khozinul Asror, Darul Jalal, Wahyu Putra Pratama, Najmul Iman Zamani and Izzat Imania contributed to the literature review, analysis, critical review, and refinement of the manuscript. All authors discussed the findings, approved the final manuscript, and are responsible for its publication.

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Upon reasonable academic request, the corresponding author will provide the data and supporting materials linked to this study.

Declaration of Interests Statement

The authors affirm that neither the research method nor the publishing of this work may have been impacted by any financial or personal conflicts of interest.

Additional Information

The writers' academic dedication to promoting cutting-edge, multidisciplinary methods in Arabic language instruction and Islamic studies led to the creation of this paper. The authors stress that this manuscript's interpretations, analyses, and conclusions are all grounded in academic honesty and scholarly concerns.

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