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Integrating Neuroembryology into Islamic Education: A Brain Development-Based Neuro-Pedagogical Framework

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ABSTRACT

The development of neuroscience has significantly influenced contemporary educational studies, particularly in understanding brain development and learning processes. However, studies integrating neuroembryology and Islamic education remain limited, especially in constructing a neuro-pedagogical framework based on brain development. This study aims to analyze the integration of neuroembryology and Islamic education in developing a brain development-based neuro-pedagogical framework. This research employed a qualitative approach using a Systematic Literature Review (SLR) method guided by the PRISMA framework. Data were collected from scientific articles indexed in Scopus, ScienceDirect, SpringerLink, DOAJ, and Google Scholar published between 2019 and 2025. A total of 42 relevant articles were analyzed using content analysis and thematic synthesis techniques. The findings reveal that neuroembryology has a significant relationship with learning readiness, emotional regulation, cognitive development, and character formation. The study also found that the principles of brain-based learning are substantially aligned with Islamic educational values such as fitrah, tarbiyah, ta'dib, tazkiyah, and akhlaq development. Based on the synthesis results, this study proposes a conceptual framework of Islamic neuro-pedagogy integrating neuroembryology, brain-based learning, and Islamic educational values into a holistic learning model. This research contributes theoretically to the integration of neuroscience and Islamic education and practically to the development of curriculum design, learning strategies, and neuroscience-based Islamic educational practices.

Keyword
neuroembryology, Islamic education, neuroscience, brain-based learning, neuro-pedagogy.

Abstrak

Perkembangan neuroscience telah memberikan pengaruh signifikan terhadap kajian pendidikan kontemporer, khususnya dalam memahami perkembangan otak dan proses belajar manusia. Namun demikian, kajian yang mengintegrasikan neuroembriologi dan pendidikan Islam masih relatif terbatas, terutama dalam pengembangan kerangka neuro-pedagogi berbasis perkembangan otak. Penelitian ini bertujuan untuk menganalisis integrasi neuroembriologi dan pendidikan Islam dalam membangun kerangka neuro-pedagogi berbasis perkembangan otak. Penelitian menggunakan pendekatan kualitatif dengan metode Systematic Literature Review (SLR) berdasarkan framework PRISMA. Data diperoleh dari artikel ilmiah yang terindeks pada Scopus, ScienceDirect, SpringerLink, DOAJ, dan Google Scholar

yang dipublikasikan pada tahun 2019–2025. Sebanyak 42 artikel yang relevan dianalisis menggunakan teknik content analysis dan thematic synthesis. Hasil penelitian menunjukkan bahwa neuroembriologi memiliki keterkaitan signifikan dengan kesiapan belajar, regulasi emosi, perkembangan kognitif, dan pembentukan karakter peserta didik. Penelitian ini juga menemukan bahwa prinsip-prinsip brain-based learning memiliki kesesuaian substantif dengan nilai-nilai pendidikan Islam seperti fitrah, tarbiyah, ta'dib, tazkiyah, dan pembentukan akhlak. Berdasarkan hasil sintesis, penelitian ini menghasilkan kerangka konseptual neuro-pedagogi pendidikan Islam yang mengintegrasikan neuroembriologi, brain-based learning, dan nilai-nilai pendidikan Islam dalam model pembelajaran holistik. Penelitian ini berkontribusi secara teoretis terhadap pengembangan integrasi neuroscience dan pendidikan Islam serta secara praktis terhadap pengembangan kurikulum, strategi pembelajaran, dan praktik pendidikan Islam berbasis neuroscience.

Kata Kunci neuroembriologi, pendidikan Islam, neuroscience, brain-based learning, neuro-pedagogi.

INTRODUCTION

Recent developments in neuroscience have made substantial contributions to the field of education, particularly in understanding how the brain develops, processes information, and shapes human learning behavior. Neuroscience is no longer viewed merely as a biological study of the nervous system; rather, it has evolved into a scientific foundation for designing learning strategies, curriculum development, and modern pedagogical approaches. In the educational context, this development has given rise to educational neuroscience and brain-based learning approaches that position brain development as a central foundation of the learning process (Gkintoni et al., 2023).

The brain-based learning approach emphasizes that effective learning should align with the way the brain naturally functions, including neurological development, emotional regulation, learning experiences, and environmental stimulation. Contemporary neuroscience studies indicate that brain development occurs progressively from the prenatal stage through processes such as neurogenesis, synaptogenesis, myelination, and neuroplasticity, all of which directly influence individuals' cognitive, emotional, and social development (Goldberg, 2022). Therefore, educational processes should ideally be designed based on learners' biological and neurological developmental characteristics rather than being solely oriented toward academic achievement.

Within the context of Islamic education, advances in neuroscience provide new opportunities for reconstructing educational paradigms that have traditionally tended to be normative and dogmatic. Fundamentally, Islamic education is not limited to the transfer of knowledge; it also seeks to develop individuals holistically through the cultivation of intellect, spirituality, emotional maturity, and moral character. Concepts such as *fitrah*, *tarbiyah*, *ta'dib*, and *tazkiyah* demonstrate that Islamic education possesses a multidimensional orientation that is highly relevant to contemporary neuroscience perspectives.

Nevertheless, contemporary Islamic educational practices continue to face several challenges, including the dominance of rote memorization methods, teacher-centered approaches, and the limited integration between religious knowledge and modern scientific disciplines. Consequently, learning processes often fail to optimize students' potential comprehensively. Asman, Suyadi, and Huda (2021) argue that Islamic education frequently adopts behavioristic approaches that position learners as passive objects of instruction, whereas neuroscience demonstrates that humans possess neuroplastic capacities enabling active and adaptive development through learning experiences.

Furthermore, the emergence of the digital era and Society 5.0 requires Islamic education to become more adaptive to social transformation, technological advancement, and the characteristics of modern learners. Today's students live in environments saturated with information, digital stimulation, and complex psychosocial changes. Such conditions require learning approaches that not only emphasize cognitive achievement but also address emotional, spiritual, and psychological balance. Raniya et al. (2025) emphasized that neuroscience-based Islamic education learning can enhance students' psychological well-being through the optimization of limbic functions, emotional regulation, and active engagement in the learning process.

Several previous studies have explored the integration of neuroscience and Islamic education, particularly in the areas of brain-based learning, character education, and neuroeducation. Kartika and Nurjayanti (2025) explained that brain-based learning is highly relevant to Islamic education because it simultaneously develops learners' cognitive, affective, and spiritual dimensions. Similarly, Miftachurrozaq and Suyadi (2023) argued that the hybridization of Islamic education and neuroscience may generate a more integrative and transformative educational paradigm.

However, most previous studies have primarily focused on optimizing brain functions in learning and have paid limited attention to neuroembryology as the biological foundation of human development in Islamic education. In fact, neuroembryology occupies a crucial position because it explains the development of the human nervous system from the embryonic stage, which forms the basis for cognitive growth, emotional development, behavioral formation, and learning readiness.

Based on these conditions, a significant research gap remains regarding the integration of neuroembryology and Islamic education, particularly in developing a brain development-based neuro-pedagogical framework. Therefore, this study aims to analyze the integration of neuroembryology and Islamic education through a systematic literature review approach in order to construct a brain development-based framework of Islamic neuro-pedagogy.

The primary contribution of this study lies in the development of a conceptual model of Islamic neuro-pedagogy that integrates neuroembryology, brain-based learning, and Islamic educational values within a holistic learning framework. This model is expected to provide a theoretical foundation for curriculum development, learning strategies, and the transformation of Islamic education toward a more adaptive, humanistic, and neuroscience-informed educational approach.

METHOD

This study employed a qualitative approach using the Systematic Literature Review (SLR) method to examine the integration of neuroembryology and Islamic education in constructing a brain development-based neuro-pedagogical framework. The SLR approach was selected because it enables a systematic, transparent, and evidence-based synthesis of scientific literature related to neuroscience, educational neuroscience, brain-based learning, and Islamic education. The review process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) framework to ensure methodological rigor and transparency in the literature selection process (Page et al., 2021).

The data sources consisted of scientific articles obtained from several academic databases, including Scopus, ScienceDirect, SpringerLink, and DOAJ as primary

databases, while Google Scholar was used as a supplementary database to broaden literature coverage. The literature search was limited to publications between 2019 and 2025 to capture recent developments in neuroscience and Islamic education studies.

The literature search process used several keyword combinations with Boolean operators AND and OR, such as "neuroembryology AND Islamic education," "brain-based learning," "educational neuroscience," "developmental neuroscience AND learning," and "Islamic education AND neuroscience." The search process initially identified 126 articles from all databases.

The article selection process was conducted through several stages following the PRISMA protocol, including identification, screening, eligibility, and inclusion. Duplicate records, non-academic publications, and irrelevant articles were excluded during the screening process. Furthermore, full-text articles were evaluated based on their relevance to the research focus, methodological clarity, conceptual contribution, and credibility of publication sources. After the selection and quality assessment process, 42 articles met the inclusion criteria and were included in the final synthesis.

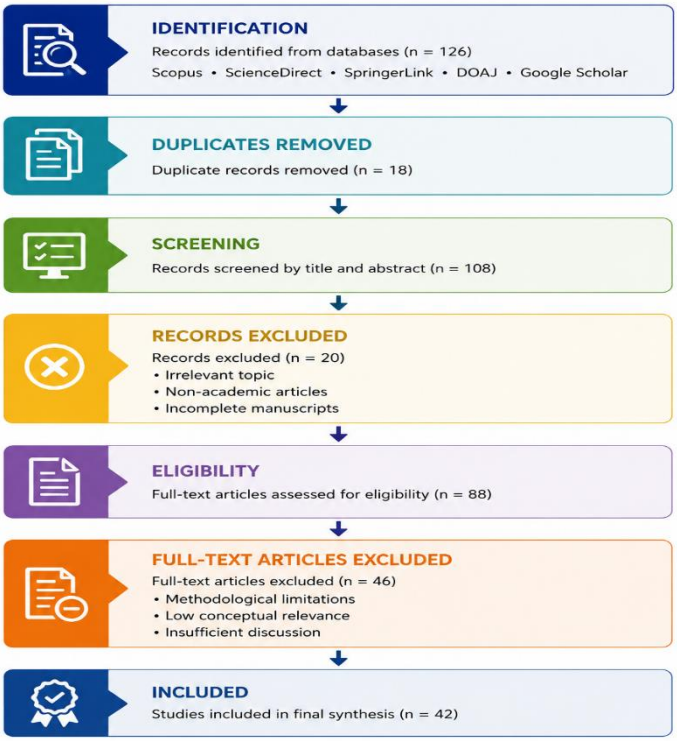

Figure 1. PRISMA 2020 Flow Diagram of Literature Selection Process

The inclusion criteria in this study focused on peer-reviewed articles discussing neuroembryology, neuroscience, brain-based learning, educational neuroscience, and Islamic education in relation to learning processes, brain development, emotional regulation, or educational practices. Meanwhile, articles lacking methodological clarity, conceptual relevance, or accessible full-text documents were excluded from the analysis.

To ensure the credibility of the selected literature, a quality assessment process was conducted by evaluating the relevance of the studies, methodological consistency, conceptual depth, and scientific contribution of each article. This process aimed to

minimize bias and strengthen the validity of the conceptual synthesis developed in this study.

Data analysis employed content analysis and thematic synthesis techniques. Content analysis was used to identify major concepts and theoretical relationships among neuroembryology, brain development, brain-based learning, and Islamic education. Subsequently, thematic synthesis was conducted through coding, categorization, interpretation, and integration of findings into broader conceptual themes. Through this analytical process, several major themes emerged, including neuroplasticity, learning readiness, emotional regulation, spiritual development, holistic learning, and Islamic neuro-pedagogy.

To enhance the trustworthiness of the findings, source triangulation was conducted by comparing literature from neuroscience, psychology, educational theory, and Islamic education studies. Critical evaluation was also applied to ensure the consistency and relevance of the selected studies. Based on these stages, this study generated a conceptual framework of Islamic neuro-pedagogy integrating neuroembryology, brain-based learning, and Islamic educational values as a holistic educational model grounded in brain development principles.

RESULTS&DISCUSSION

Distribution and Characteristics of the Reviewed Literature

Based on the results of the systematic literature review of 42 articles that met the inclusion criteria, this study found that research on neuroscience in education has developed significantly over the last five years. Most studies primarily focused on brain-based learning, neuroeducation, neuroplasticity, and the integration of neuroscience into learning processes. However, studies specifically examining the relationship between neuroembryology and Islamic education remain very limited.

The analysis revealed that most educational neuroscience studies have evolved within the paradigm of educational neuroscience, which positions brain development as the biological foundation of learning. This approach emphasizes that learning is not merely a psychological activity but also a neurobiological process influenced by the development of brain structures and functions (Jolles & Jolles, 2021). Consequently, the effectiveness of learning is strongly influenced by learners' neurological readiness.

Furthermore, the synthesis results indicated that neuroplasticity has become a central concept in contemporary educational neuroscience. Neuroplasticity refers to the brain's capacity to establish new neural connections in response to learning experiences and educational environments. Goldberg (2022) explained that human brain development remains highly dynamic throughout childhood and adolescence, indicating that learning experiences directly influence neural network formation and learners' cognitive development.

These findings suggest that effective learning should consider individuals' neurological developmental stages. Learning processes that are not aligned with brain developmental readiness may lead to cognitive overload, low learning motivation, and limited development of higher-order cognitive functions.

Table 1. Characteristics of the Reviewed Literature

Analysis Aspect	Findings
Number of articles	42 articles
Publication range	2019–2025

Dominant focus	Brain-based learning and neuroeducation
Research approach	Systematic review and conceptual research
Minor focus	Neuroembryology in Islamic education
Main finding	Brain development influences learning readiness

The findings indicate that neuroembryology has rarely been used as a foundational basis for developing pedagogical approaches in Islamic education. Most previous studies have mainly concentrated on optimizing brain functions in learning without deeply connecting them to neurological developmental stages beginning from the embryonic phase.

In fact, developmental neuroscience demonstrates that brain development from the prenatal stage significantly influences learning abilities, emotional regulation, and individuals' social development (Baker, Galván, & Fuligni, 2024). During the early developmental stages, processes such as neurogenesis, neuronal migration, and neural connection formation occur, serving as the primary foundation for later cognitive development.

The findings of this study reveal a significant research gap, namely the absence of a conceptual framework that systematically integrates neuroembryology, brain-based learning, and Islamic educational values into a comprehensive pedagogical model. This gap subsequently became the foundation for constructing the brain development-based Islamic neuro-pedagogical framework proposed in this study.

Thematic Synthesis of Brain-Based Learning and Islamic Education

The thematic synthesis of the reviewed literature indicates that brain-based learning is the most dominant instructional approach in contemporary educational neuroscience studies. This approach positions the brain as the central component of the learning process and emphasizes that instructional strategies should align with the biological mechanisms of brain functioning.

The analysis of the reviewed articles identified four major principles of brain-based learning that consistently appeared in the literature:

1. positive emotion-based learning,
2. contextual learning,
3. reinforcement and repetition,
4. multisensory stimulation.

These four principles are closely associated with neural development and learners' neuroplasticity.

Table 2. Principles of Brain-Based Learning in the Literature Synthesis

Principle	Neuroscientific Findings	Educational Implications
Positive emotions	The limbic system influences memory and attention	Learning environments should be safe and enjoyable
Contextual learning	The brain understands real experiences more effectively	Experience-based learning is more effective
Reinforcement	Repetition strengthens synaptic connections	Practice and reinforcement are essential in learning
Multisensory learning	Activation of multiple brain areas improves retention	Varied learning media enhance understanding

The synthesis findings reveal that emotions occupy a central role in the learning process. From a neuroscience perspective, the limbic system plays a crucial role in

regulating attention, motivation, and long-term memory formation. Therefore, learning environments that generate excessive psychological pressure tend to hinder learning processes due to increased neurological stress responses.

These findings are supported by the study of Syafii et al. (2025), which demonstrated that the integration of neurocognitive and spiritual strategies can enhance Muslim students' working memory and emotional intelligence through the optimization of prefrontal cortex and limbic system functions. Accordingly, learning should not merely focus on cognitive aspects but must also consider learners' emotional and spiritual conditions.

Furthermore, the analysis showed that contextual and multisensory learning significantly influence neural network formation. Learning experiences involving direct engagement, visual and auditory stimulation, and motor activities have been proven to improve neural connectivity and strengthen memory retention. These findings are consistent with the study conducted by Gkintoni, Vassilopoulos, and Nikolaou (2025), which emphasized that neuroplasticity-based multisensory learning enhances cognitive flexibility, attention, and problem-solving abilities.

Within the context of Islamic education, these brain-based learning principles demonstrate strong compatibility with the concepts of *tarbiyah* and *ta'dib*. Islamic education has historically emphasized experience, habituation, role modeling, and moral reinforcement as integral components of the educational process. For example, the concept of *takrir* (repetition) in Islamic educational traditions directly corresponds with the reinforcement mechanism in neuroscience, which explains that repetition strengthens synaptic connections within the brain.

Moreover, the synthesis findings indicate that Islamic education possesses holistic characteristics aligned with contemporary neuroscience approaches. Islamic education aims not only to develop intellectual intelligence but also emotional and spiritual intelligence. Yusuf (2023) explained that brain-based learning in Islamic education should integrate intellectual quotient (IQ), emotional quotient (EQ), and spiritual quotient (SQ) in order to develop learners comprehensively in cognitive, emotional, and spiritual dimensions.

Nevertheless, this study also found that the implementation of neuroscience in Islamic education continues to face several challenges. Most learning practices remain teacher-centered and heavily oriented toward memorization, thereby limiting the optimization of learners' neural development. In addition, limited neuroscience literacy among educators has hindered the systematic application of brain-based learning approaches within Islamic educational settings.

Therefore, the findings of this study suggest that the integration of brain-based learning and Islamic education holds significant potential for developing a more adaptive, humanistic, and brain development-oriented educational system. This integration further strengthens the argument that neuroscience and Islamic education are not contradictory paradigms; rather, they can complement one another in constructing a holistic and evidence-based educational approach.

Integration of Neuroembryology and Islamic Educational Values

The synthesis of the reviewed literature demonstrates a strong conceptual relationship between the principles of modern neuroscience and the fundamental values of Islamic education. This integration is particularly evident in concepts related to human

potential development, character formation, emotional regulation, and learners' spiritual development.

From a neuroscience perspective, brain development occurs through the process of neuroplasticity, which refers to the brain's ability to form and strengthen neural connections in response to experiences and learning environments. This concept corresponds closely with the concept of *fitrah* in Islamic education, which views human beings as possessing innate potential that must be nurtured and developed through appropriate educational processes.

The analysis of various studies indicates that Islamic education is substantively oriented not only toward intellectual development but also toward moral formation, emotional regulation, and spiritual consciousness. This orientation is highly relevant to contemporary neuroscience, which emphasizes that learning involves complex interactions among cognitive, affective, and social systems within the brain.

Table 3. Integration of Neuroscience Principles and Islamic Educational Concepts

Neuroscience Principle	**Islamic Educational Concept**	**Pedagogical Implication**
Neuroplasticity	*Fitrah*	Human potential develops through educational stimulation
Limbic system	*Tazkiyah al-nafs*	Emotions influence character formation
Neural reinforcement	*Takrir*	Repetition strengthens memory and behavior
Executive function	Development of *'aql*	Learning should encourage critical and reflective thinking
Emotional regulation	*Tarbiyah ruhiyah*	Education should balance emotional and spiritual development

The findings indicate that emotional regulation represents one of the most significant points of convergence between neuroscience and Islamic education. In neuroscience, emotional regulation is closely associated with the functions of the limbic system and prefrontal cortex, which influence self-control, decision-making, and behavioral stability. Similarly, Islamic education has historically emphasized self-restraint, patience, and moral character formation as core components of the educational process.

These findings are supported by the study conducted by Nurfitroh et al. (2025), which revealed that the integration of emotional regulation within Islamic education can enhance learners' character development and academic achievement through integrated psychological and spiritual approaches. Therefore, Islamic education possesses not only moral orientation but also neuropsychological relevance in fostering learners' emotional balance.

Furthermore, the synthesis results indicate that spirituality contributes significantly to cognitive and emotional development. Syafii et al. (2025) explained that the integration of neurocognitive and spiritual strategies can improve working memory, emotional intelligence, and attentional control among Muslim students through neuroplastic changes in the prefrontal cortex and limbic system. These findings suggest that spiritual practices produce not only theological effects but also neurological implications for the learning process.

Within the context of Islamic education, spiritual development is cultivated through various activities such as worship practices, moral habituation, *dhikr*, Qur'anic recitation, and the internalization of Qur'anic values. These activities indirectly contribute to emotional stability, attentional focus, and the development of positive behavioral patterns among learners.

Nevertheless, this study also found that modern Islamic educational practices still tend to separate spiritual and intellectual dimensions. Learning processes are often oriented toward academic achievement and rote memorization without adequately integrating learners' neurological, emotional, and spiritual development. As a result, Islamic education risks losing its holistic dimension.

In contrast, the synthesis findings indicate that the integration of neuroscience and Islamic education provides opportunities to construct a more comprehensive educational paradigm. Fatimah and Sumarni (2024) emphasized that holistic approaches in Islamic education are capable of simultaneously enhancing learners' intellectual, emotional, and spiritual development.

Therefore, the integration of neuroembryology and Islamic education not only strengthens the scientific foundation of Islamic education but also expands educational paradigms toward more holistic, humanistic, and evidence-based approaches. This integration further demonstrates that brain development, emotional regulation, and spiritual formation are interconnected elements within the broader process of human education.

Construction of the Islamic Neuro-Pedagogical Framework

Based on the findings of the literature synthesis, this study proposes a conceptual framework of Islamic neuro-pedagogy grounded in brain development principles. The framework was constructed through the integration of three primary components: (1) neuroembryology as the biological foundation of human development, (2) brain-based learning as the pedagogical approach, and (3) Islamic educational values as the normative and spiritual orientation of the learning process.

The analysis revealed that most previous studies have positioned neuroscience and Islamic education in a partial and fragmented manner. Neuroscience studies generally focus on optimizing brain function and enhancing learning effectiveness, whereas Islamic education predominantly emphasizes moral and spiritual dimensions. Consequently, there remains a lack of pedagogical models that systematically integrate neurological development, instructional strategies, and Islamic values within a unified conceptual framework.

In this study, neuroembryology is positioned as the primary foundation because brain development beginning from the prenatal stage significantly influences learning readiness, cognitive abilities, emotional regulation, and learners' behavioral formation. Therefore, educational processes should ideally be designed according to learners' neurological developmental stages rather than being solely based on standardized curricular targets.

Furthermore, brain-based learning functions as a pedagogical bridge connecting brain development with instructional practices. This approach emphasizes the importance of:

emotionally safe learning environments,
contextual learning,
multisensory stimulation,

reinforcement and repetition,
and learners' active engagement in the learning process.

These principles demonstrate strong relevance to the concepts of *tarbiyah*, *ta'dib*, and *tazkiyah* in Islamic education, which emphasize the holistic development of human beings in intellectual, emotional, and spiritual dimensions.

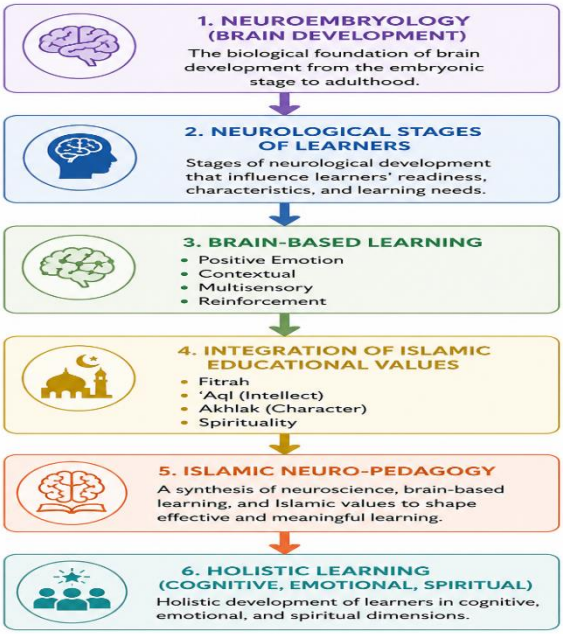

Figure 1. Brain Development-Based Islamic Neuro-Pedagogical Framework

The proposed framework illustrates that learning should not merely be understood as a process of knowledge transfer, but rather as a simultaneous neuropsychological and spiritual process. Within this model, brain development functions as the biological foundation, brain-based learning serves as the pedagogical strategy, and Islamic education provides the value-oriented framework that directs educational objectives.

These findings support the study conducted by Syafii et al. (2025), which emphasized that the integration of neurocognitive and spiritual approaches can produce neuroplastic changes that contribute to improvements in working memory, emotional intelligence, and attentional control among Muslim learners. Similarly, Ahmed and Chowdhury (2024) argued that contemporary Islamic education requires a more authentic, integrative, and contextually relevant reconstruction of educational paradigms in response to the developmental needs of modern society.

The findings of this study also demonstrate that Islamic neuro-pedagogy has significant implications for curriculum development and instructional strategies. Islamic educational curricula should not merely emphasize religious knowledge content, but should also be designed based on principles of brain development and learners' psychological needs. Consequently, learning processes become more adaptive, humanistic, and aligned with human developmental characteristics.

Nevertheless, the implementation of neuro-pedagogy continues to face several challenges. One of the major obstacles is the limited neuroscience literacy among educators. Many Islamic education teachers still rely on conventional teacher-centered and memorization-oriented instructional approaches. Furthermore, there remains a lack

of systematic integration between neuroscience research findings and the development of Islamic educational curricula within formal educational institutions.
Therefore, this study highlights the importance of:

1. strengthening neuroscience literacy among educators,
2. developing brain development-based curricula,
3. providing neuroscience-informed pedagogical training,
4. and conducting further empirical studies to examine the implementation of neuro-pedagogical models within Islamic educational contexts.

Accordingly, the neuro-pedagogical framework developed in this study not only provides a conceptual contribution but also offers a new direction for the advancement of Islamic education that is more scientific, holistic, and relevant to contemporary educational challenges.

Implications, Limitations, and Future Directions of Islamic Neuro-Pedagogy

The findings of this study indicate that the integration of neuroembryology and Islamic education has significant implications for the development of contemporary Islamic educational paradigms. The neuro-pedagogical approach not only strengthens the scientific foundation of the learning process but also provides a new direction for developing Islamic education that is more adaptive to learners' developmental needs.

From a pedagogical perspective, the synthesis findings suggest that learning processes that consider learners' neurological development are more effective in enhancing learning engagement, emotional regulation, and character formation. Therefore, Islamic education teachers need to understand that learning is fundamentally a neurobiological activity influenced by emotions, experiences, environmental conditions, and educational stimulation.

These implications require a paradigm shift from teacher-centered instruction toward more humanistic and brain development-based student-centered learning. Teachers should no longer function merely as transmitters of knowledge, but rather as facilitators capable of creating emotionally safe, contextual, and meaningful learning environments for students.

Furthermore, the findings also indicate that Islamic education possesses strong potential for developing holistic learning approaches because it conceptually integrates intellectual, emotional, and spiritual dimensions. The integration of neuroscience into Islamic education can strengthen this approach by providing scientific explanations regarding brain development and human learning mechanisms.

However, this study also identified several limitations in the implementation of neuroeducation within Islamic educational contexts. One of the primary challenges is the relatively low level of neuroscience literacy among educators. Many teachers still lack adequate understanding of brain development, neuroplasticity, and the implications of neuroscience for instructional strategies.

This condition may lead to the emergence of neuromyths or misconceptions regarding neuroscience concepts in education. Torrijos-Muelas, González-Víllora, and Bodoque-Osma (2021) explained that neuromyths remain widespread among educators due to limited scientific literacy and the gap between neuroscience research and educational practice. Such misconceptions may result in inappropriate and non-evidence-based applications of brain-based learning approaches.

Moreover, Sullivan, Hughes, and Gilmore (2021) emphasized that many claims regarding brain-based learning are often oversimplified without strong empirical support.

Therefore, the integration of neuroscience into Islamic education must be approached critically, scientifically, and proportionally in order to avoid the risk of educational pseudoscience.

This study also has methodological limitations because it employed a systematic literature review approach that remains conceptual in nature and did not empirically test the proposed neuro-pedagogical framework. Consequently, the conceptual framework developed in this study still requires further validation through field-based research conducted within Islamic educational institutions.

Table 4. Implications and Challenges of Neuro-Pedagogical Development

Aspect	Findings	Implications
Pedagogical	Learning should align with brain development	Teachers need to understand educational neuroscience
Emotional	Emotions influence learning processes	Learning environments should be safe and positive
Spiritual	Spirituality supports emotional regulation	Islamic education should adopt holistic approaches
Challenges	Limited neuroscience literacy	Teacher training is required
Risks	Emergence of neuromyths	Educational approaches must remain evidence-based

Based on these findings, this study proposes several future directions for development. First, educational neuroscience training is needed for Islamic education teachers to ensure that neuro-pedagogical implementation is conducted accurately and scientifically. Second, the development of Islamic educational curricula should incorporate principles of brain development, emotional regulation, and contextual learning. Third, empirical research is required to examine the effectiveness of neuro-pedagogical models in improving the quality of Islamic education.

In addition, future studies should develop evaluation instruments for Islamic education-based neuro-pedagogy so that the integration of neuroscience and Islamic education extends beyond conceptual discourse and can be practically implemented within educational systems.

Therefore, this study confirms that Islamic neuro-pedagogy holds considerable potential as a new educational paradigm that is integrative, holistic, and grounded in human developmental principles. Nevertheless, its implementation requires critical, scientific, and contextual approaches to ensure that the integration of neuroscience and Islamic education provides meaningful contributions to the transformation of contemporary education.

The Transformation of Islamic Education through a Neuro-Pedagogical Approach

The findings of this study indicate that the integration of neuroembryology and Islamic education not only generates a new conceptual framework but also opens new directions for transforming Islamic education to become more adaptive to human development and contemporary educational challenges. In this context, neuro-pedagogy can be understood as an educational paradigm that integrates biological brain development, neuroscience-based pedagogical strategies, and Islamic spiritual and moral values within a holistic learning system.

The findings reveal that contemporary Islamic educational systems continue to face several challenges, including:

the dominance of memorization-based approaches,
teacher-centered instructional practices,
limited integration between religious and scientific knowledge,
and the lack of learner development-based educational approaches.

These conditions often prevent learning processes from optimally developing learners' intellectual, emotional, and spiritual potential.

From a neuroscience perspective, effective learning requires active brain engagement through meaningful, emotional, and contextual learning experiences. Therefore, the transformation of Islamic education should be directed toward learning processes that:

1. are student-centered,
2. consider learners' neurological development,
3. integrate cognitive, affective, and spiritual dimensions,
4. and establish humanistic learning environments.

The literature synthesis demonstrates that this integrative paradigm is highly relevant to classical Islamic educational concepts such as *tarbiyah*, *ta'dib*, and *tazkiyah*, which emphasize holistic human development as the primary goal of education. Accordingly, neuroscience does not replace Islamic education; rather, it strengthens the scientific foundation explaining how human development occurs biologically and psychologically.

Yakin et al. (2025) explained that the hybridization of Islamic education and neuroscience creates a more holistic educational paradigm by simultaneously integrating learners' intellectual, emotional, spiritual, and social development. This approach enables Islamic education to move beyond normative-dogmatic models toward more reflective, adaptive, and evidence-based learning approaches.

Furthermore, the findings also indicate that the development of neuro-pedagogy has direct implications for the design of Islamic educational curricula. Curricula should not merely focus on the transfer of religious knowledge but should also be designed according to principles of brain development, learners' characteristics, and the cultivation of multidimensional intelligence.

Table 5. Transformation of Islamic Education through Neuro-Pedagogy

Conventional Education	**Islamic Neuro-Pedagogy**
Teacher-centered	Student-centered
Memorization-oriented	Meaningful learning
Cognitive-focused	Holistic (IQ, EQ, SQ)
Uniform instruction	Brain development-based learning
Knowledge transfer	Character and spiritual development

This transformation demonstrates that Islamic neuro-pedagogy is oriented toward the development of individuals who are not only academically competent but also possess emotional stability, spiritual awareness, social competence, and strong moral character.

These findings are reinforced by Moslimany, Otaibi, and Shaikh (2024), who argued that contemporary Islamic education requires holistic curricula integrating religious knowledge, psychological development, technology, and modern pedagogical approaches in order to address the challenges of globalization and social transformation.

Moreover, the findings indicate that the transformation of Islamic education through neuro-pedagogy requires systematic support, particularly in:

teacher training,
curriculum development,
innovation in learning media,
and research-based educational policies.

Without such support, the integration of neuroscience into Islamic education may remain merely conceptual and difficult to implement effectively in educational practice.

Therefore, this study confirms that Islamic neuro-pedagogy has considerable potential as a new paradigm for contemporary Islamic education. This paradigm not only strengthens the integration of scientific knowledge and religion but also offers a more scientific, humanistic, and developmentally relevant educational approach for modern learners.

Prospects for the Development of Neuro-Pedagogy in Contemporary Islamic Education

The findings of this study indicate that neuro-pedagogy holds broad prospects for the development of contemporary Islamic education, particularly in constructing learning systems that are more holistic, adaptive, and grounded in human development principles. The integration of neuroscience and Islamic education opens opportunities for the emergence of a new educational paradigm that not only emphasizes academic achievement but also pays attention to learners' emotional, spiritual, social, and character development comprehensively.

In the context of globalization and digital transformation, Islamic education faces complex challenges, including changes in learning patterns, rapid technological advancement, moral crises, and increasing demands for twenty-first century skills. These conditions require Islamic educational systems to move beyond traditional learning paradigms toward more integrative and transdisciplinary approaches.

The synthesis findings suggest that neuro-pedagogical approaches can serve as a strategic alternative in addressing these challenges. Neuro-pedagogy enables learning processes to be designed based on principles of brain development, learners' psychological characteristics, and Islamic spiritual values oriented toward holistic human development.

Leany and Azzam (2024) explained that the integration of Islamic psychology and early childhood education can foster balanced spiritual, emotional, and intellectual development through approaches grounded in *fitrah* and human developmental principles. These findings indicate that Islamic education possesses conceptual foundations compatible with contemporary neuroscience approaches.

Furthermore, the findings also reveal that neuro-pedagogy-based Islamic education demonstrates strong relevance to the development of holistic learning. Holistic approaches view learners as multidimensional individuals; therefore, educational processes should facilitate the balanced development of all human potentials.

Table 6. Prospects for the Development of Islamic Neuro-Pedagogy

Development Area	Contribution of Neuro-Pedagogy
Curriculum	Brain development-based and holistic learning-oriented
Learning Strategies	Student-centered and multisensory learning
Character Development	Integration of emotional, moral, and spiritual dimensions

Childhood Education	Learning aligned with neurological developmental stages
Digital Education	Adaptive and humanistic learning approaches

The findings also indicate that neuro-pedagogical approaches have important implications for the development of Islamic educational curricula. Curricula should no longer focus solely on content mastery but should also aim to cultivate critical thinking, emotional regulation, creativity, spirituality, and learners' social competencies.

Madjid (2025) explained that the transformation of Islamic boarding school education (*pesantren*) within the ASEAN region has increasingly moved toward holistic educational models integrating cognitive, affective, and spiritual dimensions through educational psychology approaches. These findings demonstrate that the transformation of contemporary Islamic education is progressively oriented toward integrative and humanistic learning models.

On the other hand, the development of digital technology also provides new opportunities for implementing Islamic neuro-pedagogy. The use of interactive learning media, audiovisual technologies, artificial intelligence, and multisensory learning approaches can support the optimization of learners' neural development when applied appropriately and in accordance with principles of brain development.

Nevertheless, this study also emphasizes that the development of neuro-pedagogy should not diminish the epistemological identity of Islamic education. The integration of neuroscience and Islamic education must remain grounded in the values of *tauhid*, morality, and spirituality to ensure that education produces not only intellectually capable individuals but also individuals with moral awareness and social responsibility.

Therefore, Islamic neuro-pedagogy possesses significant potential as a future paradigm of Islamic education capable of integrating modern scientific developments with Islamic values in a holistic manner. This approach is not only relevant to advances in neuroscience and contemporary educational psychology but is also aligned with the objectives of Islamic education in developing *insan kamil*—individuals who are intellectually, emotionally, spiritually, and socially balanced.

CONCLUSIONS

This study demonstrates that neuroembryology provides significant contributions to the development of contemporary Islamic education, particularly as a biological foundation for understanding learning processes, cognitive development, emotional regulation, and learners' character formation. The findings of the literature synthesis reveal that the principles of brain-based learning are substantively connected with Islamic educational values such as *fitrah*, *tarbiyah*, *ta'dib*, and *tazkiyah*.

The primary contribution of this study lies in the construction of a brain development-based Islamic neuro-pedagogical framework that integrates neuroembryology, brain-based learning, and Islamic spiritual values into a holistic learning model. This framework expands the existing discourse on the integration of neuroscience and Islamic education, which has previously remained largely partial and normative in nature.

Theoretically, this study strengthens the paradigm of integrating scientific knowledge and religion within Islamic education. Practically, the findings provide important implications for curriculum development, instructional strategies, and teacher training based on educational neuroscience. Accordingly, Islamic neuro-pedagogy has the potential to become a more adaptive, humanistic, and relevant educational approach for

addressing the challenges of twenty-first century education. Nevertheless, this study remains conceptual in nature; therefore, further empirical research is required to examine the implementation and effectiveness of the proposed neuro-pedagogical model within Islamic educational practices.

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