

Neuroscience and Islamic Education: Optimizing Cognitive Function in Learning

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Article history: Received: July-31-2026 | Revised: Aug-01-2026 | Available

Online: Aug-10-2026

ABSTRACT

Education is a very urgent matter in life, even the spearhead of a nation is determined by the education within it. However, the current education system pays less attention to how to learn well, how to maximize brain work and brain function properly, which is considered important only that relates and focuses on the left brain and often ignores the right brain function. Even though education and teaching without involving knowledge about the brain as a whole is impossible. This research was created to increase awareness of the importance of knowing how the brain works and maximizing it so that subject matter is not only memorized but can also be deeply understood and stored in long-term memory. This writing is qualitative writing in a descriptive form. Qualitative writing is writing that departs from naturalistic inquiry whose findings are not obtained from statistical calculation procedures. Qualitative writing methods as methods to explore and understand meaning, natural context, and participant perspectives, not just numbers or statistical generalizations. After conducting research related to Neuroscience in Islamic Learning, it can be concluded that neuroscience is able to increase understanding of Islamic concepts more deeply, form sustainable religious attitudes, and encourage moral and spiritual values of children in their daily lives. It is also proven to optimize brain function and strengthen the relationship between religious knowledge, appreciation, and practice in everyday life. From the results of this study, it should be a reference and implementation material in teaching so that learning can maximize children's brain function and learning can be understood and stored in children's long-term memory.

Keywords: Cognitive Function, Islamic Education, Learning, Neuroscience.

INTRODUCTION

Law of the Republic of Indonesia Number 20 of 2003 concerning the National Education System emphasizes that national education functions to develop abilities and form a dignified national character and civilization in order to educate the nation's life. Education is directed to develop the potential of students to become human beings who believe and fear God Almighty, have noble character, are healthy, knowledgeable, capable, creative, independent, and become democratic and responsible citizens. The mandate places the learning process not only as a means of knowledge transfer, but also as a process of developing the potential of students as a whole. In the context of contemporary education policy, this spirit is manifested, among other things, through the Independent Curriculum which provides wider space for educational units and teachers to design learning according to the needs, characteristics, and potential of students (Dewi, 2021; Sarnoto, 2024). This orientation demands learning that not only focuses on material achievement, but also encourages active engagement, creativity, independence, and meaningful learning experiences.

One perspective that can be used to understand the learning process more comprehensively is neuroscience. Neuroscience provides an understanding that the learning process is related to the brain's activity in receiving, processing, storing, and recalling information. Therefore, the success of learning is not only determined by the materials and methods used, but also by the conditions that allow learners to pay attention, manage emotions, build learning experiences, and develop memory. In this perspective, the learning process is an activity that involves the interaction between cognitive and affective aspects. Students' emotional states, such as anxiety, pressure, and tension, can affect their readiness to receive and process information. On the contrary, a safe and positive learning environment can support student involvement in the learning process (Tokuhama-Espinosa, 2021; Manan, 2024; Wasul & Suyadi, 2025).

The neuroscience perspective is becoming increasingly relevant in the learning of Islamic Religious Education (PAI) because the purpose of PAI does not stop at the mastery of religious knowledge, but also includes the appreciation of values and the formation of behaviors. PAI learning ideally provides opportunities for students to understand the material cognitively while connecting it to experiences, emotions, and daily life. Thus, learning that only emphasizes memorization has the potential to result in mastery of material at the surface level if it is not accompanied by a process of meaning and internalization of values. Several studies show that PAI learning practices still face problems in the form of dominance of conventional methods, including lectures and memorization, which can limit students' active involvement in the learning process (Sumiati, 2022; Assabiq & Wantini, 2024). This condition shows the importance of developing learning strategies that are able to integrate cognitive, emotional, and learning experiences of students.

In that context, neuroscience-based approaches can provide perspectives to understand various learning strategies oriented towards attention, engagement, emotions, multisensory experiences, and memory reinforcement. The use of songs, storytelling, audiovisual media, multisensory activities, and the creation of a fun learning atmosphere, for example, can be part of a pedagogical strategy that provides a more diverse learning experience to students. In PAI learning, these strategies can be used to help students understand Islamic material through more concrete and contextual experiences. The integration of cognitive and spiritual aspects is also important because PAI learning has different characteristics from learning that is solely oriented towards the mastery of knowledge. Studies on neuroscience-based Islamic education show the importance of paying attention to the relationship between cognitive development, emotional experiences, and the spiritual dimension in the educational process (Suyadi, 2022; Assabiq & Wantini, 2024; Luthfiyani et al., 2024).

Although the study of neuroscience in education continues to grow, research that specifically describes how neuroscience principles are applied in PAI learning practices in primary schools still needs to be strengthened. Some studies have more discussed neuroscience at a conceptual level or explained its relationship to the educational process in general. Meanwhile, how PAI teachers translate these principles into daily learning strategies, how teachers build students' attention and emotional atmosphere, and how the use of multisensory experiences and learning media is applied in the delivery of Islamic values require a more contextual empirical study. Thus, there is a gap between the conceptual discussion of the importance of neuroscience in learning and the empirical picture of its application in PAI learning in primary school.

This research seeks to fill this gap by focusing attention on PAI learning practices at SDN Lenteng Timur 1, Sumenep Regency. The research does not place neuroscience as a separate learning method, but as a perspective to analyze the pedagogical strategies used by teachers in building attention, engagement, emotion management, multisensory experiences, and students' understanding. The novelty of the research lies in the qualitative mapping of the form of application of these principles in elementary school PAI learning, including the use of Asmaul Husna songs, storytelling of prophetic stories, audiovisual media, and the creation of a fun learning atmosphere. This focus is expected to show how the principles of neuroscience are translated into the practice of learning Islamic values at the elementary school level.

Based on this description, this study aims to analyze the form of implementation of neuroscience principles in PAI learning, identify learning strategies used by teachers, and describe their contribution to student attention, engagement, and understanding. This research uses a qualitative approach to obtain a deeper picture of teachers' experiences and practices in implementing learning that is in harmony with the principles of neuroscience. Thus, this research is expected to make an empirical contribution to the development of PAI learning that is more contextual, meaningful, and pays attention to the integration between the cognitive, emotional, and spiritual aspects of students.

METHOD

Research Design

This study uses a qualitative approach with a case study design. A qualitative approach is used to understand phenomena in depth based on the experiences, views, and practices of informants in the natural context of research (Creswell & Poth, 2018). The case study design was chosen because the research focuses on an in-depth exploration of a phenomenon in a real-life context, thus allowing the researcher to gain a contextual understanding of the application of neuroscience principles in the learning of Islamic Religious Education (PAI) (Yin, 2018).

The approach is in accordance with the focus of research that is not directed at examining the relationship or influence between variables statistically, but to describe how teachers apply learning strategies related to attention, engagement, emotion management, multisensory experiences, and student understanding. In qualitative research, researchers become the main instruments that interact directly with data sources in the natural context of research (Creswell & Poth, 2018).

The research will be carried out in August 2025 at SDN Lenteng Timur 1, Sumenep Regency, Madura. The selection of the research location is based on its suitability with the focus of the research, namely PAI learning practices at the elementary school level. The research is directed to obtain a contextual picture of the application of neuroscience principles in PAI learning activities.

Research Subjects and Informants

The research informants were determined using purposive sampling techniques. This technique is used when researchers select informants based on certain considerations related to the goals and focus of the research (Creswell & Poth, 2018). The research informants consisted of five PAI teachers, namely two male teachers and three female teachers, who had the responsibility of teaching in grades I to VI.

The selection of PAI teachers as the main informants is based on their direct involvement in planning and implementing the learning process. Through these informants, the researcher obtained information about learning strategies, management of classroom conditions, the use of learning media, and teachers' experiences in building students' attention and involvement. In qualitative research, the selection of informants purposively allows researchers to obtain rich and relevant information to the phenomenon being studied (Patton, 2015).

Technical Data Collection

Data collection was carried out through observation, semi-structured interviews, and documentation. The use of several data collection techniques is intended to obtain in-depth information while allowing researchers to cross-examine data obtained from various sources (Creswell & Poth, 2018).

Observations were made on the PAI learning process to directly identify the strategies used by teachers in building attention, creating a positive emotional atmosphere, involving students in multisensory activities, and using songs, storytelling, audiovisual media, and other learning activities. Observation in qualitative research allows researchers to obtain data on participants' behaviors and activities in their natural context (Creswell & Poth, 2018).

Semi-structured interviews were conducted with five PAI teachers to obtain information about the teachers' experiences, understanding, and considerations in implementing learning strategies related to neuroscience principles. Semi-structured interviews provide space for researchers to use pre-prepared questions as well as develop follow-up questions based on informant answers (Creswell & Poth, 2018).

Documentation is used as a source of supporting data to complement the information obtained through observation and interviews. The documents used include learning tools, teaching materials, learning media, and other documents relevant to the implementation of PAI learning. The use of documentation can help researchers understand the context of the research while strengthening the information obtained through other data collection techniques (Yin, 2018).

Data Analysis

Data were analyzed using the interactive model of Miles, Huberman, and Saldaña which included data condensation, data presentation, and conclusion drawing and verification (Miles, Huberman, & Saldaña, 2014). The analysis is carried out interactively and takes place continuously during the research process, so that researchers can return to the data if information is found that requires further deepening or verification.

The first stage is data condensation. At this stage, the data from interviews, observations, and documentation is selected, focused, simplified, abstracted, and transformed according to the focus of the research (Miles, Huberman, & Saldaña, 2014). The data was then grouped based on themes related to neuroscience-based learning strategies, emotion management, attention stimulation, multisensory activities, use of learning media, and student involvement.

The second stage is data presentation (data display). The condensed data is presented in the form of narrative descriptions and thematic tables to show the patterns and relationships between themes found. The presentation of data helps researchers to systematically see patterns

and determine the information needed for further interpretation (Miles, Huberman, & Saldaña, 2014).

The third stage is conclusion drawing and verification. Initial conclusions were developed based on patterns that emerged from the data and subsequently verified through re-examination of the results of interviews, observations, and documentation. The verification process is carried out on an ongoing basis to ensure that the conclusions produced have adequate and consistent evidence support (Miles, Huberman, & Saldaña, 2014).

Data Validity

The validity of the data is carried out through source triangulation and technique triangulation. Source triangulation was carried out by comparing information obtained from five PAI teachers, while technical triangulation was carried out by comparing the results of interviews, observations, and documentation. Triangulation is used to increase the credibility of findings by comparing information obtained through different sources or data collection techniques (Creswell & Poth, 2018).

In addition to triangulation, the analysis process is carried out repeatedly by re-examining the data and findings that have been obtained. This step aims to ensure that the interpretation of the research remains based on empirical data and not solely based on the assumptions of the researcher. With this procedure, the research is expected to produce credible findings regarding the implementation of neuroscience principles in PAI learning in elementary schools.

RESULTS AND DISCUSSION

Findings (can be in form of subheading)

The findings of this study indicate that Islamic Religious Education (PAI) teachers at SDN Lenteng Timur 1 have implemented a number of learning strategies that are in line with neuroscience principles, including the use of Asmaul Husna songs, *storytelling* of the stories of the prophets, the use of audiovisual media, and the creation of a fun learning atmosphere. These strategies have been empirically proven to be able to increase students' enthusiasm, attention, and understanding of PAI materials. These findings are consistent with a number of previous studies that show that neuroscience-based approaches to PAI learning either through cooperative models (Azizah & Suyadi, 2022), strengthening religious character (Huda, 2022), developing higher-level thinking skills (Lestari & Suyadi, 2021), and learning Tahsinul Qur'an (Mubin, 2021) consistently contribute positively to the quality of students' learning processes and outcomes.

Neuroplasticity as an Explanatory Framework

The findings reinforce the theory of neuroplasticity, which asserts that the brain has an intrinsic capacity to form and reconfigure new synaptic connections through meaningful learning experiences (Pandey, 2024). The activities of singing, storytelling, and the use of audiovisual media in this study present multisensory stimulation that allows information to be processed through various sensory pathways simultaneously, thereby strengthening the encoding mechanism and consolidation of information in long-term memory. Thus, the increase in students' understanding in this study can be interpreted as a manifestation of the neuroplastic process that occurs during learning an explanation that is in line with the principle that structural and functional changes at the synaptic level underlie the process of knowledge acquisition and retention (Pandey, 2024).

The Role of the Limbic and Amygdala Systems in Emotion-Cognition Regulation

The teachers in this study create a fun learning atmosphere through songs and stories, so that students feel emotionally comfortable during the learning process. From an affective neuroscience perspective, the amygdala plays a central role in processing the emotional valence

of a stimulus and interacts closely with the prefrontal cortex and medial temporal lobe in modulating attention and memory consolidation (Šimić et al., 2021). Positive emotional states allow students' attentional resources to be more effectively focused on relevant information, while a psychodially stressful learning atmosphere tends to inhibit high-level cognitive function. This explanation provides the neuroscience foundation for the high enthusiasm and learning engagement of students observed in this study.

It should also be noted that in practice, some neuroscience-based learning studies still refer to the Cannon-Bard theory as a framework for explaining the relationship between emotions and physiological responses. Nevertheless, from an academic point of view, it is important to assert that a more relevant explanation supported by contemporary empirical evidence is the role of the amygdala in emotion processing and memory modulation as outlined above, given that Cannon-Bard's theory is essentially a general theory of emotion and not one specifically designed to explain the mechanisms of learning.

Triune Brain and Brain-Based Learning

The results of this study can also be analyzed through the *Triune Brain* framework developed by MacLean, which presupposes coordination between the limbic system as the center of emotion regulation and the neocortex as the center of high-level cognitive processing. Learning activities that begin with songs, stories, and audiovisual media in this study seem to first activate the emotional-limbic components of students, so as to create conducive affective conditions before academic information is processed rationally by the neocortex. Nonetheless, it is academically necessary to underline that the validity of *the Triune Brain as a model of the structural evolution of the brain* has been widely questioned in the contemporary neuroscience literature. Steffen et al. (2022) show that the assumption of gradual and layered evolution of the human brain (from the reptilian brain to the limbic system and then the neocortex) is not entirely consistent with the current understanding of neurobiological evolution, so this framework is more accurately understood as a pedagogical heuristic model than an accurate anatomical description. With such a note of caution, the basic principle that emotional engagement precedes and facilitates cognitive processing remains relevant and supported by more up-to-date affective neuroscience findings (Šimić et al., 2021).

The principle of *brain-based learning* emphasizes that effective learning ideally begins with the creation of a psychologically safe learning atmosphere, followed by the process of information acquisition, elaboration, memory consolidation, and integration of learning experiences. Teachers in this study, inexplicitly, have implemented these stages through fun apperception activities, the use of varied learning media, and learning orientations centered on student experience. The effectiveness of this approach is also confirmed by an experimental study by Amjad et al. (2022), which showed that the application of *brain-based learning strategies* including *visual storytelling* and multisensory activities significantly improves the learning outcomes of elementary school students.

Contributions to Previous Research

Judging from previous research, these findings are consistent with educational neuroscience studies that confirm that learning strategies that pay attention to emotional, multisensory, and experiential aspects of learning are able to increase student motivation, concentration, and learning outcomes (Amjad et al., 2022; Azizah & Suyadi, 2022). However, this research provides a relatively distinctive academic contribution because it implements a specific neuroscience approach to the learning of Islamic Religious Education at the elementary school level. Most previous studies have tended to examine the application of neuroscience to general learning, such as mathematics (Amjad et al., 2022) or cross-subject HOTS (Lestari & Suyadi, 2021), while this study shows that neuroscience principles can also be effectively adapted into the learning of Islamic values through songs, prophetic stories, and audiovisual media

tailored to the characteristics of the psychological development of elementary school-age children (compare with Huda, 2022; Mubin, 2021).

CONCLUSION

Based on the results of the research, it can be concluded that the application of neuroscience principles in the learning of Islamic Religious Education (PAI) at SDN Lenteng Timur 1 Sumenep Regency is carried out through various strategies that pay attention to the cognitive, emotional, and learning experiences of students. These strategies include managing the emotional atmosphere of learning, the use of multisensory activities, storytelling, Asmaul Husna songs, and the use of audiovisual media. The application of this strategy shows that PAI learning is not only directed at the delivery and mastery of the material, but also at the creation of learning experiences that can build students' attention, engagement, and understanding.

The results of the study also show that the management of a safe and fun learning environment is an important part of supporting student involvement during the learning process. Learning strategies that involve visual, auditory, verbal, and experiential activities provide a variety of stimulation that allows learners to participate in learning more actively. In the context of PAI learning, the strategy also helps teachers convey Islamic values through more concrete, contextual, and meaningful learning experiences.

Thus, neuroscience in this study can be understood not as a stand-alone learning method, but as a perspective that helps teachers understand the importance of attention, emotional states, multisensory experiences, and memory processes in learning. The findings of the study indicate that the application of these principles has the potential to support the quality of PAI learning in elementary schools. However, because this study uses a qualitative approach, the findings are not intended to prove a causal relationship or statistically influence between the application of neuroscience and the cognitive function of learners.

This research provides the implication that PAI teachers need to consider the cognitive and emotional aspects of students in designing learning experiences. The use of varied, contextual, multisensory, and fun strategies can be an alternative in creating more active and meaningful PAI learning. Further research can develop these findings through a quantitative approach or mixed methods with tested cognitive function measurement instruments so that the relationship between neuroscience-based learning strategies and the development of students' cognitive function can be empirically tested.

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