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Application Of Neuroplasticity Principles In Primary School Learning : Analysis Of Instruments And Interviews With Teachers At Dharma Putra Primary School

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Abstract
This study aims to examine in depth the application of neuroplasticity principles in learning at elementary schools, focusing on the teaching practices of five teachers at SDS Dharma Putra. Neuroplasticity, as a core concept in neuroscientific learning, describes the brain's ability to form, strengthen, or modify neural networks through experience, repetition, meaningful activities, and students' emotional involvement. Given the characteristics of elementary school students who are at a stage of cognitive development that is highly responsive to learning environment stimulation, a study of the application of neuroplasticity by teachers is important to ensure that the learning process is in line with the brain's working mechanisms.This study used a neuropsychological instrument measuring the dimensions of neuroplasticity to assess four main indicators, namely repetition & practice, dedicated time for review, use of interactive activities, and contextual learning that connects the material to students' real experiences. The data was reinforced through in-depth interviews and thematic analysis of the learning strategies applied by each teacher. The results showed variations in application between teachers. Some teachers showed strong implementation in interactive activities and contextual learning (score of 5), while structured repetition showed lower consistency (score of 3). The interview findings reinforced the instrument results by showing patterns of strategies such as the use of inspirational stories, educational games, quizzes with prizes, conveying the benefits of learning, and scaffolding through easy material as a starting point. This study concludes that the application of neuroplasticity principles is present in teachers' teaching practices, although the level of depth and routine still needs to be strengthened. The theoretical implication confirms that learning that integrates positive emotions, collaborative activities, planned repetition, and contextualization of material has the potential to have a significant impact on the formation of students' neural networks. Practically, this study provides recommendations for strengthening neuroscientific learning-based instructional design as an effort to optimize the learning process of elementary school students.

Abstract
Penelitian ini bertujuan untuk mengkaji secara mendalam penerapan prinsip neuroplastisitas dalam pembelajaran pada satuan pendidikan dasar, dengan fokus pada praktik pengajaran lima orang guru di SDS Dharma Putra. Neuroplastisitas sebagai konsep inti dalam neuroscientific learning menggambarkan kemampuan otak untuk membentuk, memperkuat, atau memodifikasi jejaring saraf melalui pengalaman, pengulangan, aktivitas bermakna, dan keterlibatan emosional siswa. Mengingat karakteristik siswa sekolah dasar yang berada pada tahap perkembangan kognitif yang sangat responsif terhadap stimulasi lingkungan belajar, kajian mengenai penerapan neuroplastisitas oleh guru menjadi penting untuk memastikan bahwa proses pembelajaran selaras dengan mekanisme kerja otak. Penelitian ini menggunakan instrumen neuropsikologi dimensi neuroplastisitas untuk menilai empat indikator utama, yaitu *repetition & practice*, waktu khusus untuk *review*, penggunaan aktivitas interaktif, serta pembelajaran kontekstual yang menghubungkan materi dengan pengalaman nyata siswa. Data diperkuat melalui wawancara mendalam dan analisis tematik terhadap strategi pembelajaran yang diterapkan oleh setiap guru. Hasil menunjukkan adanya variasi penerapan antara guru satu dengan yang lain. Sebagian guru menampilkan penerapan kuat pada aspek aktivitas interaktif dan pembelajaran kontekstual (skor 5), sedangkan aspek pengulangan terstruktur menunjukkan konsistensi yang lebih rendah (skor 3). Temuan wawancara menguatkan hasil instrumen dengan menunjukkan pola strategi seperti penggunaan cerita inspiratif, permainan

edukatif, kuis berhadiah, penyampaian manfaat pembelajaran, hingga scaffolding melalui materi yang mudah sebagai tahap awal. Penelitian ini menyimpulkan bahwa penerapan prinsip neuroplastisitas telah hadir dalam praktik pengajaran guru, meskipun tingkat kedalaman dan rutinitasnya masih perlu diperkuat. Implikasi teoritisnya menegaskan bahwa pembelajaran yang mengintegrasikan emosi positif, aktivitas kolaboratif, pengulangan yang direncanakan, dan kontekstualisasi materi berpotensi memberikan dampak signifikan bagi pembentukan jaringan saraf siswa. Secara praktis, penelitian ini memberikan rekomendasi penguatan desain pembelajaran berbasis neuroscientific learning sebagai upaya optimalisasi proses belajar siswa sekolah dasar.

Kata Kunci: neuroplastisitas, motivasi belajar, sekolah dasar

INTRODUCTION

Modern learning increasingly emphasizes the importance of approaches that are in line with how the brain learns, in line with the development of neuroscience studies in the world of education. One of the main concepts that forms the basis for the development of brain-based learning strategies is neuroplasticity, which is the ability of the human brain to continuously change, develop, and adapt through experience. This concept affirms that the brain is not a static structure, but rather dynamic and can be strengthened through practice, repetition, emotional stimulation, and active individual involvement in the learning process. For elementary school students who are in a period of rapid cognitive, social, and emotional development, teaching processes that are in line with the principles of neuroplasticity are very important to facilitate growth and the formation of long-term mindsets.

In the context of primary education in Indonesia, the implementation of a neuroscientific learning-based approach remains a challenge, both due to teachers' limited understanding and learning designs that do not fully integrate the biological and psychological aspects of child development. Therefore, examining teachers' practices in applying the principles of neuroplasticity is an important step in identifying the extent to which this understanding is translated into daily learning activities.

This study focuses on SDS Dharma Putra, an elementary school that served as the location for data collection through neuropsychological instruments and in-depth interviews with five teachers. These instruments assess four main indicators of the application of neuroplasticity in learning, namely: (a) providing opportunities for practice and repetition;(b)providing special time to review material; (c) using interactive activities such as discussions, exercises, or educational games;(d)linking learning material to students' real experiences.

All data was sourced from instrument reports and interviews, including field observation findings that reinforced the analysis. This approach provides a comprehensive picture of how teachers design learning environments that potentially support the strengthening of students' neural networks. In addition, in-depth interviews containing strategies for opening lessons, the use of inspirational stories, challenges, rewards, and scaffolding provide rich qualitative data related to the mechanisms teachers use to foster students' motivation to learn new things.

This study is important not only for understanding learning practices at SDS Dharma Putra, but also for contributing to the development of neuropedagogical implementation in elementary schools more broadly. By understanding the level of implementation and the challenges faced by teachers, the results of this study can form the basis for recommendations aimed at optimizing neuroplasticity-based learning in elementary education.

METHOD

Research Design and Participants This study aims to examine the application of neuroplasticity principles in learning at the elementary school level. The study was conducted at Dharma Putra Primary School, involving five teachers as the main participants. The study focused on the teaching practices applied by these teachers in the classroom.

Data Collection Instruments Data collection was carried out using two main techniques to ensure data validity and depth, The following diagram:

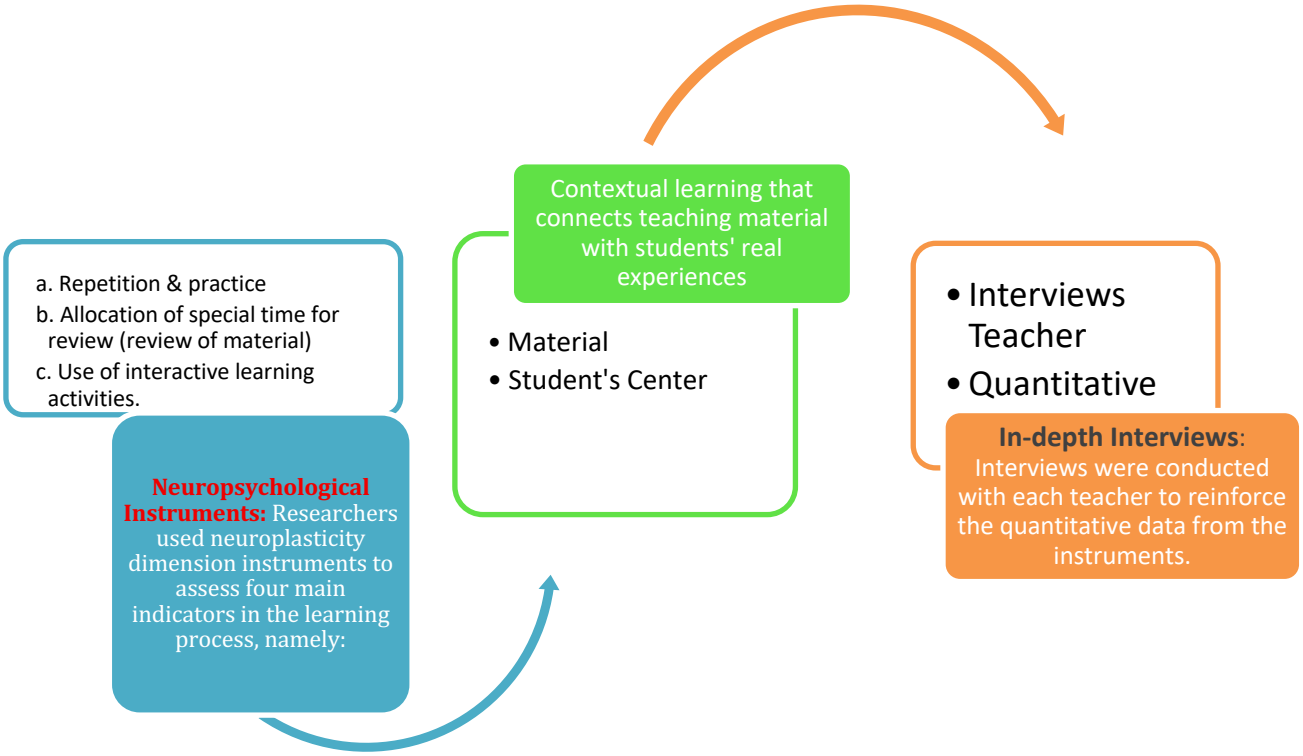


Figure 1. Research Design Diagram

These interviews aimed to explore the understanding and reasons behind the learning strategies they applied. Data Analysis Techniques The collected data was analyzed using thematic analysis techniques. This analysis focused on identifying patterns in the learning strategies applied by teachers to see the alignment between field practices and the principles of neuroplasticity.

RESULTS AND DISCUSSION

This discussion aims to interpret the research results by relating them to the main theories of neuroplasticity, neuropedagogical concepts, and brain-based learning principles. The analysis was conducted by considering three sources of data: neuropsychological instruments, in-depth interview results, and field observations.

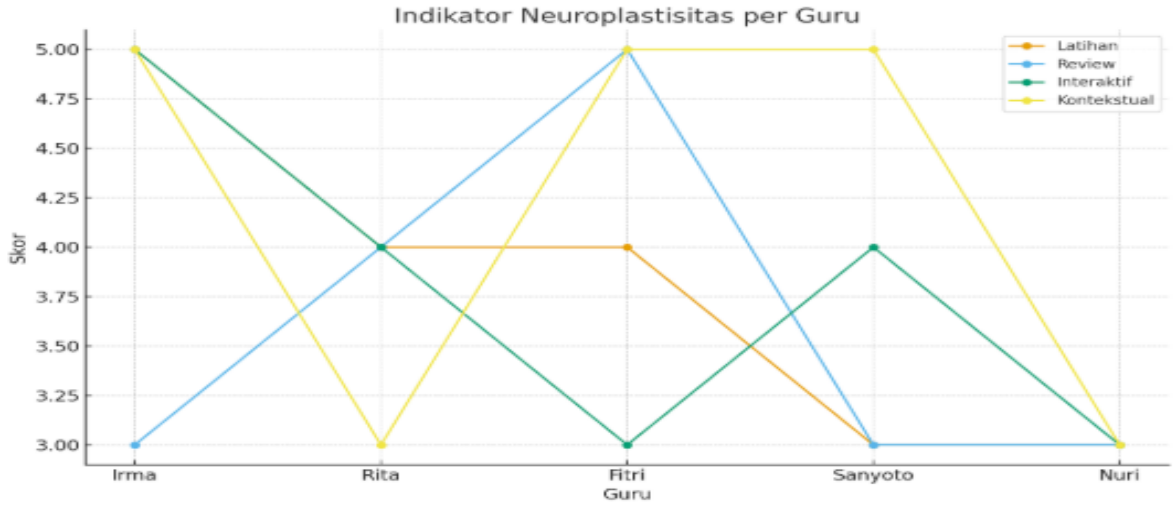
Table 1. Findings – Problems – Solutions – Theoretical Basis

Research Findings	Issues Found	Recommended Solutions	Theoretical Basis
Repetition is still uneven among teachers.	No daily review routine.	Create a daily review schedule and spaced repetition for each lesson.	Hebbian Learning; LTP; Zull (2017).
High interactive activity among some teachers, but low among others.	Teachers lack creativity or time to design activities.	Active learning design workshop and collaborative activity bank.	Brain-Based Learning; Limbic Learning.

Contextual learning is very powerful but not yet evenly distributed.	Teachers of exact subjects find it difficult to relate the material to real-world contexts..	Development of contextual learning modules for each subject.	Vygotsky (Contextual Learning).
Teachers still predominantly use extrinsic rewards.	Student motivation does not last long.	Integrating project-based learning and personal goals (self-goal setting).	Self-Determination Theory.
Storytelling is only used by a few teachers	Students lose focus at the beginning of the lesson.	Storytelling as a standard operating procedure for opening lessons .	Narrative Neuroscience; Hughes & Long (2018).
Student reflection activities are not very visible.	Learning does not facilitate the internalization of concepts.	Adding a daily reflection journal or exit-ticket reflection.	Kolb Experiential Learning

Table 2. Mapping of Neuroplasticity Indicator Scores per-Teacher

Teacher	Practice & Repetition	Independent/Group Review	Interactive Activities	Contextual Learning	General Profile
Bu Irma	5	3	5	5	Very strong in interactive and contextual activities. Reviews are not yet routine.
Bu Rita	4	4	4	3	Consistent, but the context of mathematical material is sometimes abstract.
Bu Fitri	4	5	3	5	Excellent in review and contextual aspects; needs improvement in interactive activities.
Pak Sanyoto	3	3	4	5	Strong storytelling; practice and review are still moderate.
Bu Nuri	3	3	3	3	All aspects are moderate; potential is enhanced with interactive training.



connections strengthen when used repeatedly. Instrument findings show that teachers at SDS Dharma Putra understand the importance of repetition, but its implementation varies. Teachers such as Ms. Irma and Ms. Fitri place repetition as an integral part of learning (score 4–5). Meanwhile, Mr. Sanyoto and Ms. Nuri tend to do it situationally, not routinely (score 3), (pp. 25–26). This inconsistency shows that even though teachers recognize the importance of practice, factors such as learning design, time allocation, or subject characteristics become obstacles in the application of structured repetition.

Theoretically, the lack of scheduled repetition can hinder the process of long-term potentiation (LTP), which is the strengthening of synapses that forms the basis of long-term memory. Therefore, teachers need to ensure that repetition is not only done when needed, but becomes a systematic part of the learning routine.

Interactive Activities as Triggers for Emotional Learning. The findings show that teachers who use intensive interactive activities such as educational games, group discussions, challenges, or quizzes—have higher neuroplasticity scores. This is consistent with the theory that positive emotions increase the release of dopamine, which plays an important role in strengthening synapses and increasing learning motivation (Goleman, 2019). Interactive activities create emotional conditions that support learning, making it easier for students to retain information and build connections between concepts. In particular, practices such as: intergroup challenges (Ms. Irma), quizzes with prizes (Ms. Rita), and hands-on/experiential activities (Ms. Nuri), serve as emotional stimuli that accelerate the neuroplasticity process.

Contextual Learning as a Mechanism for Cognitive Integration: Contextual learning indicators received the most consistently high scores among teachers. Teachers such as Ms. Irma, Ms. Fitri, and Mr. Sanyoto actively linked the material to students' real lives (score of 5). Contextual learning strengthens cognitive integration because: (a) the brain finds it easier to store information that is considered meaningful; (b) understanding increases when students see the connection between the material and their lives; (c) the activation of relevant areas of the brain increases when information has personal relevance.

This is in line with Zull's (2017) findings that real experiences trigger whole brain engagement and facilitate the formation of more stable neural pathways.

Storytelling as a Cognitive and Emotional Stimulus: The interviews showed that storytelling was used by several teachers, especially Mr. Sanyoto, who began the lesson with stories related to current events or inspirational history. Stories are capable of: (a) activating the limbic system (emotion management),(b) building focus and curiosity, (c)creating cognitive bridges between old and new knowledge. This is consistent with narrative-based learning theory that the human brain is naturally programmed to respond to stories.

The Relationship Between Teacher Strategies and Neural Network Formation: Opening Strategies as Cognitive Priming Mechanisms: Every teacher has different opening strategies, but they all serve the same function: to facilitate students' cognitive readiness before receiving new material. Examples of opening strategies: (a) learning outlines and objectives increase cognitive orientation (Ms. Irma); (b) explanation of the benefits of learning increase a sense of relevance (Ms. Fitri); (c) inspirational or actual stories trigger curiosity (Ms. Nuri, Mr. Sanyoto). In neuroscience theory, this process is called cognitive priming, which is a condition where the brain is prepared to receive new stimuli so that it is easier to form neural connections.

Gradual Activities and Scaffolding in the Formation of Stable Networks: Some teachers, especially Ms. Fitri, use an approach that starts with easy material before moving on to more difficult material. This approach: builds self-efficacy, activates existing neural pathways as a basis for forming new ones, reduces learning anxiety. These findings are in line with Vygotsky's (2012) theory of the Zone of Proximal Development (ZPD) and the role of scaffolding in helping students exceed their initial abilities.

Reinforcement as a Synaptic Strengthener**:** The use of rewards, both verbal (praise) and non-verbal (small gifts, extra points), is a strategy consistently used by teachers. In neuroscience, reinforcement accelerates synaptic strengthening through dopaminergic pathways. This helps students associate learning with pleasant experiences, thereby increasing motivation and retention. However, research findings show that many teachers still rely on extrinsic motivation, which in the long run is weaker than intrinsic motivation. Therefore, there is a need to shift from "reward-based learning" to "meaning-driven learning."

Alignment of Findings with Brain-Based Learning**: l**earning is Physiological**:** Teachers who use interactive activities, educational games, or stories have created emotional conditions that engage the limbic system, increasing the brain's readiness to learn. Learning is Developmental: A gradual approach (scaffolding), conveying benefits, and gradual reinforcement are in line with the cognitive development stages of elementary school students. Learning is Contextual: Teachers who apply contextual learning facilitate long-term memory integration through the relevance of experiences. Thus, the practices of Dharma Putra Elementary School teachers are in line with the three pillars of brain-based learning, although their implementation still varies among teachers.

Challenges in Implementing Neuroplasticity in Learning: Although the application of neuroplasticity principles is already evident, there are a number of challenges that must be considered: Lack of Consistency in Structured Repetition. Repetition is still done when needed, not as a routine.

Extrinsic motivation still dominant: Rewards are the main motivator, so a transition to meaning-based intrinsic motivation is needed. Interactive Activities Are Not Uniform: Not all teachers are able to consistently implement interactive activities. Storytelling Has Not Become a Teaching Tradition**:** Even though this technique has been proven to be very effective in brain-based learning. Theoretical and practical implications

theoretical Implications: this study reinforces the view that effective learning is not only cognitive, but also emotional and social. Teachers act as "architects of learning experiences" who shape students' neural structures through meaningful activities. Practical Implications**: s**chools need to: design micro-curricula with scheduled review sessions; improve teachers' capacity in using storytelling; develop learning patterns that encourage intrinsic motivation; expand the use of interactive and collaborative activities.

CONCLUSION

Research on the application of neuroplasticity principles in learning at SDS Dharma Putra has produced a number of important findings that enrich the neuropedagogical literature in the context of elementary schools in Indonesia. Based on instrument analysis, interviews, and observations, it can be concluded that the implementation of neuroplasticity principles is already significantly present in learning practices, although the level of depth and consistency varies among teachers. First, the aspect of repetition which is the basis of Hebbian Learning theory and the long-term potentiation (LTP) mechanism has been applied, but has not yet become a routine part of learning. Teachers such as Ms. Irma and Ms. Fitri showed high levels of repetition (scores of 4–5), while other teachers were still at a

moderate level (score of 3). This shows that the strengthening of students' neural pathways is not yet fully optimal without scheduled repetition.

Second, the implementation of dedicated review time also shows variation. Ms. Fitri is the only teacher who implements review consistently (score 5), while other teachers do so situationally. This review routine is important for long-term memory consolidation, but still faces obstacles such as time constraints and curriculum load.

Third, interactive activities such as educational games, group discussions, collaborative activities, and quizzes with prizes have proven to be the most effective strategies for increasing student motivation and emotional engagement. Teachers who implement these strategies (such as Ms. Irma and Ms. Rita) scored high on the neuroplasticity indicator. This is in line with limbic learning and affective neuroscience theories, which state that positive emotions increase memory retention through dopamine activation.

Fourth, the aspect of contextual learning is the most dominant strength. Teachers such as Ms. Fitri, Ms. Irma, and Mr. Sanyoto (score 5) are able to relate the material to the students' real experiences, thereby supporting the construction of meaning as described in Vygotsky's constructivism theory and Ausubel's concept of meaningful learning.

Fifth, interviews show that teachers have applied various brain-based learning strategies, such as: storytelling, explaining the benefits of learning, providing challenges, using rewards, scaffolding from easy material. These strategies neurologically support the formation of new neural pathways through a combination of cognitive, emotional, and social stimuli. However, this study also revealed several important challenges. Student motivation is still predominantly based on external rewards, while intrinsic motivation has not been fully developed. In addition, not all teachers consistently implement interactive activities and storytelling, even though both have been proven to be very effective in stimulating neuroplasticity. Student reflective learning is also still limited, so the integration of long-term concepts is not yet optimal. In general, this study concludes that SDS Dharma Putra has applied the principles of neuroplasticity in learning, but still requires systematic reinforcement in the planning, execution, and evaluation of neuroscience-based learning. Contextual and interactive learning strategies are already a strength, but structured repetition and the development of students' intrinsic motivation need to be improved.

These findings have significant theoretical and practical implications. Theoretically, this study confirms that elementary school teachers' practices can be aligned with modern neuroscience principles even though they have not been explicitly formalized. Practically, schools need to strengthen policies and teacher training related to brain-based learning so that the formation of students' neural networks can be more optimal, consistent, and sustainable.

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