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# NEUROSCIENCE-BASED LEARNING TO IMPROVE READING LITERACY OF SLOW LEARNER STUDENTS IN ELEMENTARY SCHOOL: A CASE STUDY

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## ABSTRACT

This research aims to explore the effectiveness of neuroscience-based learning innovations in improving the reading literacy of slow learner students in elementary schools through a case study at SDN 1 Perumnas Condongcatur. The method used is a descriptive qualitative approach, employing data collection techniques such as observation, interviews, and documentation. The results showed that the multisensory approach, which combines visual, auditory, and kinesthetic aspects, succeeded in improving students' reading skills, both in terms of letter recognition, syllable combinations, and simple reading comprehension. The findings also indicate an increase in students' confidence and motivation to learn after the implementation of this learning model. Despite challenges such as limited facilities and differences in students' comprehension levels, these results reinforce previous literature stating that neuroscience-based approaches can maximize the neuroplasticity potential of children with special needs. This study recommends the importance of teacher training and provision of adequate facilities to optimize neuroscience-based learning outcomes in primary schools.

Keywords: Neuroscience, Reading Literacy, Slow Learner, Inclusive Education, Multisensory Learning.

## INTRODUCTION

Neuroscience-based learning is an educational approach that integrates knowledge about how the brain works to improve learning effectiveness. (Puspitasari, 2024). In the context of primary education, neuroscience helps teachers understand how the brain processes information, including the development of reading skills in children. According to (Azzahra et al., 2024) Educational neuroscience informs pedagogical practice by integrating science, psychology, and education to develop strategies that align with children's brain development. Specifically, in reading literacy, brain activity involves simultaneous processing of visual, phonological, and semantic information. (Rahmawati et al., 2020). Therefore, neuroscience-based learning has great potential in designing effective interventions to improve reading literacy, particularly for students with learning disabilities, such as those who are slow learners.

Slow learner students are those who have cognitive potential below average but still within the normal range, which causes them to take longer to understand lessons. Reading literacy difficulties are one of the primary challenges for students who are slow learners, as they

often struggle with recognizing letters, sounding out words, and comprehending reading (Mansyur, 2022). According to Muhajirin et al. (2023), the characteristics of slow learner students require a learning approach that can respond appropriately to individual needs. Neuroscience provides a strong foundation, as it enables teachers to apply methods that align with the rhythms and working patterns of students' brains (Riveros et al., 2021). This approach has significant advantages, one of which is strengthening neural connections related to literacy skills (Setiawan et al., 2023).

The importance of innovation in literacy learning has been emphasized in recent studies. Reading literacy is a key foundation for students' academic success, as literacy difficulties can have a lasting impact on their educational development. (Ferrari et al., 2024). The study conducted by (Adimsyah et al., 2023) Showed that neuroscience-based interventions can improve the learning motivation and academic outcomes of students with special needs. Similarly, research (Hainora Hamzah et al., 2022) Confirms that learning methods that utilize neuroeducational principles are proven to increase the effectiveness of literacy learning at the primary school level. Therefore, it is important to adopt a neuroscience-based approach, especially in the context of inclusive education, which is gaining increasing attention in the national curriculum. (Ferrari et al., 2024).

However, a significant research gap remains in the Indonesian context. Most educational neuroscience studies in Indonesia still focus on regular students or general learning without paying specific attention to the needs of students with learning difficulties. (Hadi et al., 2023). Studies on the application of neuroscience to the reading literacy of slow learner students in primary schools, particularly through in-depth case studies, are still minimal. (Satriani, 2022)This opens up opportunities to further explore how neuroscience-based innovations can be effectively applied in Indonesian primary schools, which have unique contexts in terms of both culture and resources. (Hadi et al., 2023). In addition, neuroscience-based learning, combined with relevant local practices, is also a new area that is still rarely explored in research. (Hakim, 2023).

The novelty of this research lies in the development of a learning model aimed explicitly at slow learner students with a systematic and contextual neuroscience-based approach. Not only designing innovation, this research also presents an empirical evaluation through case studies in elementary schools to see its effectiveness directly. (Ramadhani et al., 2024)This model is expected to make a new contribution to Indonesian educational literature, which currently lacks neuroscience studies in the context of inclusive basic education. (Urbaningkrum et al., 2024)In addition, this innovation aligns with the direction of education policy, which emphasizes the importance of evidence-based education and an individualized approach. (Aulia et al., 2024).

This study aims to develop and test a neuroscience-based learning model that can enhance the reading literacy of elementary school students with learning difficulties. Specifically, this research aims to: (1) identify the learning needs and characteristics of slow learner students in the field of reading literacy; (2) design a learning model that utilizes neuroscience principles systematically; (3) implement the model in real learning in the classroom; and (4) analyze the impact of the model on improving the reading literacy of slow learner students. The results of this study are expected to serve as a practical and theoretical reference for teachers, curriculum developers, and policymakers to strengthen neuroscience-based inclusive education practices in Indonesia.

## LITERATURE REVIEW

Neuroscience-based learning has become an increasingly popular approach in modern education as it bridges learning theory with biological processes in the brain. Tokuhama-Espinosa (2020). Educational neuroscience studies how the brain processes information and how learning strategies can be adjusted to maximize learning outcomes (Dia, 2025). According to (Aini et al., 2024) Neuroscience-based learning not only increases student engagement but also optimizes long-term memory through a developmentally appropriate approach. This is in line with (Ramadhani et al., 2024) This suggests that applying neuroscience principles in basic education can accelerate the acquisition of basic literacy.

Reading literacy is one of the most important aspects that students must master early on, as it forms the foundation for success in other subjects. However, students with slow learning often experience significant barriers in reading literacy due to their cognitive limitations. (Ferra.ri et al., 2024). (Muammar, 2022) Initial reading ability has a significant influence on subsequent skills, including reading comprehension. In other words, initial reading aims to provide students with the ability to understand and articulate writing with natural intonation as a basis for further. (Muammar et al., 2023). A.ccording to (Khasyia et al., 2024) Slow learner students need more structured and intensive interventions, as well as approaches that are adaptive to their learning rhythms. Recent research by (Anwar et al., 2024) Additionally, it confirms that learning methods utilizing neuroscience-based approaches are proven to be more effective in improving phonological skills and reading comprehension in this group, as they optimize the brain's synaptic pathways.

One of the primary advantages of neuroscience-based learning is its capacity to create a learning environment that not only focuses on teaching materials but also considers students' emotional and social factors (Riveros et al., 2021). Emphasizes that affection factors play a

significant role in the success of the literacy process, especially for students with special needs, such as those with learning difficulties (Setiawan et al., 2023). It was also mentioned that neuroscience-based learning design should consider aspects of intrinsic motivation, as high emotional involvement can strengthen memory consolidation. The findings support this (Ultabaini, 2024) by showing that slow-learning students who were emotionally engaged in the learning process demonstrated significant improvement in reading ability.

The limitation of previous research is that there are still few studies that explicitly test the effectiveness of neuroscience-based learning on the reading literacy of slow learner students in elementary schools, especially in Indonesia. Research by (T. Y. Setiawan et al., 2022) Shows that although the concept of neuroscience has begun to be integrated into the curriculum, its application remains general and has not explicitly addressed the needs of students with learning difficulties. (Khasyia et al., 2024) It is noted that this innovative learning approach still lacks a standardized model that has been widely tested in the context of inclusive education in Indonesia. This is reinforced by (Adimsyah et al., 2023) Who stated the need for more in-depth research that integrates neuroscience, pedagogy, and the individual needs of students with special needs?

Innovation in neuroscience-based learning necessitates collaboration among teachers, neuroscientists, and curriculum developers to develop a comprehensive and applicable model. (Nuryanto et al., 2024) Suggest that learning innovations are based on the results of student needs assessments and supported by strong scientific evidence. (Firdaus et al., 2025) Highlights the importance of teacher training in understanding the fundamentals of neuroscience for effective implementation of learning. (Tuhuteru et al., 2023) Added that with technological support such as neurofeedback devices, teachers can monitor students' literacy development in a more measured and precise manner.

Overall, the literature suggests that neuroscience-based learning holds excellent potential for enhancing the reading literacy of students with learning difficulties. However, to ensure success, a systematically developed learning model that is tested in a real-world context is required. The research to be conducted in this study is expected to fill the gap by providing new empirical evidence related to the effectiveness of neuroscience-based learning models developed specifically to improve the reading literacy of slow learner students in primary schools.

## METHODOLOGY

This research employs a qualitative approach, specifically a case study type, as explained by Creswell et al. (2007). Qualitative research aims to understand phenomena in depth

through direct interaction with subjects in their natural context. The focus of this research is to examine neuroscience-based learning innovations that improve the reading literacy of students with learning difficulties in elementary schools. The research location is at SDN 1 Perumnas Condongcatur, especially in class IV. The research sample consisted of 10 students with learning difficulties, who were selected purposively based on recommendations from their class teachers and initial assessment results.

The primary instrument in this research is the researcher, assisted by supporting instruments that include observation, interviews, and documentation. Observations were made to observe learning activities and student behavior during the process. In-depth interviews were conducted with classroom teachers and students to explore their experiences and perceptions of applying the neuroscience approach. Documentation was used to collect supporting data, including teacher notes, student learning outcomes, and learning tools. The data obtained will be analyzed both descriptively and qualitatively, using the processes of data reduction, data presentation, and conclusion drawing.

## RESULT AND DISCUSSION

The results obtained from the research have to be supported by sufficient data. The research results and the discovery must provide the answers to the research hypothesis stated previously in the introduction.

### 1. Reading Literacy of Slow Learner Students

Initial observations were made of 10 slow-learning students in Class IV of SDN 1 Perumnas Condongcatur. The results showed that most students had difficulty in fundamental aspects of literacy, such as recognizing letters, combining syllables, and understanding short readings. Of the total students observed, six students were only able to read simple words, three students still stuttered even though they recognized letters, and one student was unable to read at all (Observation, 2025). The class teacher said, "These children have a high frustration level when reading. They often give up before trying" (Teacher A, Interview, 2025).

These results align with those of Listiawati et al. (2023), who reported that slow learners typically exhibit deficits in working memory and phonological processing speed. Ferrari et al. ( also reported that slow learner students showed reluctance in literacy activities due to

repeated failed learning experiences. Reinforced that delays in literacy acquisition are the biggest challenge in inclusive classrooms (Ramadhani et al., 2024).

### 2. Design and Implementation of Neuroscience-Based Learning

The results obtained from the research have to be supported by sufficient data. The neuroscience-based learning model adopted in this study is designed with a focus on a multisensory approach. The activities implemented include: (1) phonics learning with colorful cards, (2) story reading with the help of visual and sound props, and (3) comprehension exercises through word games (Documentation, 2025). During the first six sessions, observations showed an increase in student attention, which initially only lasted 10-15 minutes, to around 25-30 minutes in the seventh to eighth sessions.

The class teacher said, "At first they were easily bored, but with methods that involve many senses, children become more enthusiastic" (Teacher B, Interview, 2025). Students also expressed similar opinions: "I like playing charades with pictures, it is easier to remember" (Student C, 2025).

This approach aligns with Tokutama Espinosa. (Rahman et al., 2025) The recommendations of those who emphasize the importance of multisensory learning for children with special needs (Setiawan et al., 2023). (Chusna et al., 2024) Mentioned that neuroscience-based learning triggers activation of brain areas associated with language and short-term memory, while stating that integration between cognitive and affective strengthens the learning process of slow learner students.

### 3. Improvement in Reading Literacy after Intervention

After 8 weeks of implementation, the reading literacy measurement results showed significant progress. Seven students who were previously only able to read disconnected words were now able to read simple sentences, while two others began to combine syllables more fluently. Only one student still had significant difficulties, despite showing improvement in letter recognition (Documentation, 2025). The class teacher emphasized: "One of the indicators of success that we see is the increased courage of children to read in front of the class. This is very different compared to before the intervention" (Teacher A, Interview, 2025). Another student said: "Now I am more confident reading storybooks" (Student D, 2025).

These results align with the existing research. (Mas et al., 2024) Of. Who found that a neuroscience-based approach improved the phonology and vocabulary skills of slow-learning students (Riveros et al., 2021). It was also stated that emotional activation in the learning process can enhance literacy learning outcomes. These findings confirm the neuroplasticity theory proposed by (de Sousa Junior et al., 2021) Children's brains have high flexibility in responding to appropriate interventions.

### 4. Implementation Challenges and Deterrents

Although favorable results were achieved, some challenges also emerged. Teachers reported that some students continued to struggle with keeping up with the class's rhythm, despite adjustments to the methods. "There are children who need more repetition than others, and this is a challenge when you have to accommodate the whole class" (Teacher B, Interview, 2025). Another challenge was the lack of adequate teaching aids, which had hampered the smooth implementation of the neuroscience method.

This challenge was reinforced by (Setiawan et al., 2023) Who highlighted the lack of teacher training and inadequate facilities as the main barriers to implementing neuroscience in primary schools. This was also found in a study. (Ferrari et al., 2024)This states that the success of the intervention depends on the continuity and support of educational institutions.

### 5. Comparison with Previous Studies

In contrast to (Bagas et al., 2025) This study, which focuses solely on using visual media to improve the literacy of students with learning difficulties, combines several aspects of neuroscience, including visual, auditory, and kinesthetic learning, simultaneously. This finding reinforces the study's findings. (Khasyia et al., 2024) This states that multisensory combinations are more effective than single methods in improving literacy.

In addition, this study provides contextual evidence from Indonesia, in contrast to Tokuhama-Espinosa's (2020) study, which used more school contexts in developed countries. This is an important contribution as it fills the void of neuroscience-based studies in Indonesian primary education, as suggested by (Hasibuan et al., 2022).

## CONCLUSIONS

This study successfully demonstrated that neuroscience-based learning can have a significant positive impact on the reading literacy of students with learning difficulties in

primary school. Through tailored multisensory interventions, there was a measurable improvement in students' reading ability and learning engagement. Although challenges such as limited resources remain, the results of this study prove that the neuroscience approach is one of the innovative solutions worth implementing in the context of inclusive education in Indonesia.

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