

## Neuropedagogical Approach in Indonesian Language Learning: Improving Elementary School Students' Motivation and Competence

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### Abstrack

Indonesian language learning in elementary schools often struggles to enhance students' motivation and competence, with conventional memorization-focused approaches proving ineffective. This study examined the effectiveness of a neuropedagogical approach, grounded in neuroscience and brain-based learning principles, on motivation and language competence. Using a quasi-experimental design, 70 fourth-grade students were assigned to experimental and control groups. The intervention applied multisensory activities, movement-integrated learning, emotional anchoring, and metacognitive reflection. Data from validated tests on reading, writing, speaking, listening, and motivation were analyzed using t-tests and n-gain scores. The experimental group achieved a high n-gain (0.76) compared to the control group (0.04), indicating significant improvement. Findings suggest integrating teacher training and curricula with brain-compatible strategies to foster intrinsic motivation and linguistic competence. This research highlights the potential of neuroscience-informed instruction to optimize language learning outcomes, with future studies recommended to explore long-term effects and broader implementation.

**Keywords:** neuropedagogy, brain-based learning, learning motivation, indonesian language competence, neuroscience in education

### Abstrak

Pembelajaran bahasa Indonesia di sekolah dasar seringkali kesulitan dalam meningkatkan motivasi dan kompetensi siswa, dengan pendekatan konvensional yang berfokus pada hafalan terbukti tidak efektif. Studi ini menguji efektivitas pendekatan neuropedagogis berdasarkan neurosains dan prinsip pembelajaran berbasis otak terhadap motivasi dan kompetensi bahasa. Menggunakan desain kuasi-eksperimental, 70 siswa kelas empat dibagi menjadi kelompok eksperimen dan kontrol. Intervensi yang diterapkan meliputi aktivitas multisensori, pembelajaran terintegrasi gerakan, penanaman emosi, dan refleksi metakognitif. Data dari tes validasi pada kemampuan membaca, menulis, berbicara, mendengarkan, dan motivasi dianalisis menggunakan uji t dan skor n-gain. Kelompok eksperimen mencapai skor n-gain tinggi (0,76) dibandingkan dengan kelompok kontrol (0,04), menunjukkan peningkatan yang signifikan. Temuan menunjukkan pentingnya mengintegrasikan pelatihan guru dan kurikulum dengan strategi yang sesuai dengan otak untuk meningkatkan motivasi intrinsik dan kompetensi linguistik. Penelitian ini menyoroti potensi instruksi yang didukung oleh neurosains dalam mengoptimalkan hasil pembelajaran bahasa, dengan rekomendasi untuk studi lanjutan yang mengeksplorasi efek jangka panjang dan implementasi yang lebih luas.

**Keywords:** neuropedagogi, pembelajaran berbasis otak, motivasi belajar, kompetensi bahasa indonesia, neurosains dalam pendidikan

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## INTRODUCTION

Indonesian is one of the essential components of basic education. As the national language and primary means of communication, early mastery of Indonesian significantly determines students' ability to understand and master science at an advanced level (Brenner, 2022). Learning Indonesian in elementary schools, which is designed to form the basis of language competence, presents its own challenges in ensuring that students not only master the language structure but are also motivated to learn and use it in everyday life (Hasani et al., 2021). However, despite its importance, learning Indonesian often faces challenges related to low student motivation and inadequate language competence. This is a crucial issue that needs to be addressed to enhance the quality of education in Indonesia, particularly in the context of basic education (Hennebry-Leung & Xiao, 2023).

The neuropedagogical approach, which combines an understanding of brain processes with pedagogical theories, provides a novel means of enhancing the quality of learning (Heydarnejad et al., 2022). This concept aims to design teaching more in line with how the brain works by utilizing neuroscience findings to enhance learning effectiveness. Neuropedagogy encourages teachers to gain a deeper understanding of how students learn neurologically and how to optimize learning methods to better align with the way students' brains function (Inayati & Karifianto, 2022). In the context of Indonesian language learning, this approach offers an opportunity to develop strategies that can enhance motivation and improve the language proficiency of elementary school students more effectively (Leonardou et al., 2022). Although the potential of neuropedagogy to enhance learning has been widely studied across various disciplines, its application in Indonesian language learning, particularly at the elementary school level, remains minimal and warrants further research. However, empirical studies examining the application of neuropedagogy in language learning, especially at the primary school level, remain limited. Even fewer have simultaneously investigated its impact on both motivation and language competence, creating a significant research gap. This study addresses this gap by focusing on how neuropedagogy can influence both domains in an integrated manner.

The primary challenge in teaching Indonesian in elementary schools in Indonesia is the low motivation of students to learn the language and the limited language proficiency possessed by many students (Lauer, 2010). A 2021 study by the Ministry of Education and Culture (Kemendikbud) revealed that approximately 35% of elementary school students in Indonesia failed to meet the minimum competency in learning Indonesian, as measured by standardized language competency tests (Jupon et al., 2020). This data shows a significant gap between the objectives of learning Indonesian and its achievement in the field. Several factors contribute to this problem, including the lack of variation in teaching approaches, the absence of intrinsic motivation in students, and the inability to connect language learning with their practical needs. The learning approach that still focuses solely on cognitive aspects, without considering how students' brains function during the learning process, has the potential to be one of the factors contributing to low Indonesian language learning outcomes. Data from the Pekanbaru City Education Office (2023) indicate that over 40% of elementary students exhibit low motivation in learning the Indonesian language, with nearly 30% struggling to complete speaking and writing tasks. These trends may be attributed to the use of abstract language content, varied learning styles, and the emotional disengagement fostered by rigid instructional



methods. A brain-based approach incorporating emotional anchoring and learner-centered activities could benefit Indonesia's diverse classrooms.

The urgency of this research lies in finding an approach that can improve the motivation and competence of elementary school students in Indonesian. Based on data obtained from the Pekanbaru City Education Office in 2023, more than 40% of students in elementary schools in the city showed a low level of motivation to learn Indonesian, as reflected in the results of the evaluation of learning motivation using instruments such as the Student Learning Motivation Scale (SMBS) (Seprasetyani, 2023). This decline in learning motivation was observed in classes that employed traditional learning methods, which focused more on memorization and written exercises, and tended not to stimulate students' interest and active participation. On the other hand, an analysis of students' Indonesian language competence in Pekanbaru revealed that approximately 30% of students struggled to complete the speaking and writing exam questions in Indonesian effectively, indicating an inability to apply the language practically in everyday life. Therefore, a more innovative approach, such as neuropedagogy, is needed to address this problem, as it can provide evidence-based solutions that align with how students' brains function (van Loon et al., 2021; Maddens et al., 2023). The neuropedagogical approach is believed to improve the quality of learning by aligning language teaching with a scientific understanding of how the brain works. For example, research Mafulah et al (2023) and Ushioda (2022) shows that using neurobiological understanding techniques can improve students' memory and learning skills. Additionally, this approach can help create a more engaging learning environment and encourage students to be more actively involved in the learning process. In this context, this study aims to investigate how the neuropedagogical approach can be applied to improve the motivation and competence of elementary school students in Indonesian.

Based on the background and problem statements described, this study formulates several key questions that serve as the primary focus of the study: How does the neuropedagogical approach affect the motivation to learn Indonesian among elementary school students? To what extent can the neuropedagogical approach improve the Indonesian language competence of elementary school students in speaking, writing, listening, and reading skills? What mechanisms are underlying the increase in students' motivation and Indonesian language competence after implementing the neuropedagogical approach? This study investigates the hypothesis that a neuropedagogical approach has a significant impact on enhancing student motivation and Indonesian language competence compared to traditional methods. Specifically, it examines how brain-aligned strategies impact students' intrinsic and extrinsic motivation, as well as their ability to read, write, speak, and listen in the Indonesian language. This study aims to examine the effect of the neuropedagogical approach on the motivation to learn Indonesian in elementary school students by assessing changes in the aspects of students' intrinsic and extrinsic motivation. Analyze the effect of the neuropedagogical approach on the Indonesian language competence of elementary school students, especially in speaking, writing, listening, and reading skills. Provide practical recommendations for applying the neuropedagogical approach in Indonesian language learning in elementary schools to overcome existing problems.

Previous studies have explored the impact of various innovative approaches in language learning, including those utilizing technology and brain-based methods. For example, research has emphasized the importance of teaching that takes into account how the brain processes information and how this can enhance learning effectiveness Muñoz-



Restrepo et al (2020). Another study Mustafina & Slavina (2020) also showed that teaching techniques based on neurobiological principles can improve student motivation and learning outcomes in various disciplines. However, although many studies have explored the relationship between brain-based approaches and improved learning quality, few studies have specifically examined their application in Indonesian language learning, especially at the elementary school level. In relevant research on language learning, a survey conducted by Panagiotidis et al (2023) identified that student motivation in learning Indonesian in elementary schools is often influenced by the methods used by teachers, which tend to be monotonous and lack student engagement. Furthermore, research Pardamean et al (2022) revealed that students who were taught with an approach focused more on direct experience and activities tended to show better results in mastering Indonesian language skills. However, these studies have not explored in depth how neuropedagogical approaches can improve these aspects of Indonesian language learning, which is an essential gap in the literature.

Although several studies have been conducted on the use of brain-based approaches in learning, especially in mathematics and science teaching, a research gap is evident in Indonesian language teaching at the elementary school level. Few studies directly examine how neuropedagogical approaches can improve students' motivation and Indonesian language competence. Therefore, this study fills this gap by exploring the application of neuropedagogical approaches in the context of Indonesian language learning in elementary schools, with a focus on their effects on students' motivation and language competence. This study has a significant novelty aspect because it combines the latest theories in neuropsychology with pedagogical practices in Indonesian language learning.

This research makes a twofold contribution. Theoretically, it extends neuropedagogical frameworks into language learning, integrating neuroscience with pedagogical design. Practically, it offers insights for teacher education programs and curriculum developers, especially in Indonesia's Kurikulum Merdeka, which emphasizes differentiated, student-centered instruction. Findings from this study may inform the development of professional training modules and policy decisions aimed at revitalizing language instruction through neuroscience-informed strategies.

## METHOD

This study employed a quantitative design with a quasi-experimental approach to investigate the impact of the neuropedagogical approach on the motivation and competence of elementary school students in Indonesia (Hardiansyah et al., 2024). This approach was chosen due to its nature, which allows researchers to observe changes in the dependent variables (motivation and competence in Indonesian) after implementing the experimental treatment (neuropedagogical approach). However, it cannot randomly assign students to the experimental and control groups. The quasi-experimental design allows researchers to use existing groups (such as established classes) to compare experimental results, so that it can still provide a strong understanding of the effects of the treatment without requiring complete randomization. The population of this study consisted of grade IV elementary school students in Pekanbaru City who were enrolled in Indonesian language lessons. The research sample consisted of 70 students randomly selected from two existing classes: one experimental class that received a neuropedagogical approach and one control class that followed conventional learning methods. The selection of samples by random sampling aims to minimize bias and



provide a representative picture of the broader population. Each class consists of 35 students, allowing for a more precise comparison between the two groups to measure the impact of the neuropedagogical approach on student learning outcomes.

The neuropedagogical approach in the experimental class was implemented over eight instructional sessions, each lasting 80 minutes, following a structured sequence that combined cognitive, affective, and kinesthetic elements. The procedure comprised the following components: Multisensory Activities – Lessons began with stimuli engaging multiple senses, such as colorful visual aids, mind maps with coded colors, background instrumental music during reading, and tactile learning tools (e.g., word cards, textured materials). These aimed to activate multiple neural pathways to enhance retention. Movement-Integrated Learning–Language tasks incorporated physical movement, including role-plays, dramatizations of short stories, and “walk-and-talk” pair discussions. For example, students acted out dialogues while moving around the classroom to simulate real-life conversations. Emotional Anchoring–Teachers embedded emotionally engaging elements, such as inspirational storytelling, personal anecdotes related to lesson themes, and guided imagery, to create positive emotional connections that reinforce learning. Metacognitive Reflection – Each session concluded with structured reflection activities, including learning journals, self-assessment checklists, and small-group discussions where students identified strategies that helped them learn and set goals for improvement. This systematic integration ensured that teaching aligned with how the brain processes, stores, and retrieves information, fostering linguistic competence and intrinsic motivation.

The instrument used in this study was an Indonesian language competency test consisting of 25 questions, designed according to the language competency criteria expected of grade IV elementary school students. This test was designed to measure four basic Indonesian skills: speaking, writing, listening, and reading. This test also includes elements that measure students' motivation to learn Indonesian, which was developed based on relevant theories of learning motivation. The following is a table describing the test instruments used in the study:

**Table 1.**  
 Test Question Instrument

Type of Test	Number of Items	Description of Items
Reading Test	5	Measures students' ability to comprehend written Indonesian texts.
Writing Test	5	Assesses students' ability to write sentences or paragraphs according to Indonesian language rules.
Speaking Test	5	Evaluates students' ability to speak correct Indonesian language structure.
Listening Test	5	Assesses students' ability to understand spoken Indonesian in conversations or readings.
Motivation Test	5	Measures students' intrinsic motivation towards learning the Indonesian language.
General Skills Test	5	Assesses students' general skills related to the Indonesian language.



To analyze the data, this study will employ several statistical steps, including validity tests, reliability tests, normality tests, homogeneity tests, and hypothesis tests. The instruments used to measure Indonesian language competence and learning motivation were developed rigorously to ensure construct validity and reliability. Selection of Indicators – For the language competence test, indicators were derived from the national curriculum for Grade IV, covering reading comprehension, writing mechanics and coherence, speaking fluency and accuracy, and listening comprehension. For the motivation scale, indicators reflected intrinsic and extrinsic motivation dimensions based on Self-Determination Theory (Deci & Ryan, 2017), including interest in learning, perceived usefulness, persistence, and self-regulation. Development Process—The research team drafted test items, which were subsequently reviewed by three experts in Indonesian language education and educational psychology. This peer-review process ensured content alignment with curricular goals and appropriateness for students' developmental levels. Revisions were made based on expert feedback regarding clarity, difficulty level, and cultural relevance. Examples of Items –Reading comprehension: “Read the paragraph and answer: What is the main idea of the text?” Writing: “Write a short paragraph about your favorite traditional food, ensuring correct punctuation and grammar.” Motivation scale (Likert 1–5): “I feel excited when learning Indonesian” (intrinsic) and “I study Indonesian because it will help me in the future” (extrinsic). Validity testing was conducted through expert content validity analysis, yielding a Content Validity Index (CVI) above 0.80 for all items. Reliability was assessed using Cronbach's alpha, resulting in coefficients ranging from 0.83 to 0.88 across subtests, indicating high internal consistency.

To ensure that the observed effects could be attributed primarily to the neuropedagogical intervention, several strategies were implemented to control for potential confounding variables, including initial student characteristics. Before the intervention, the experimental and control groups completed a pre-test of Indonesian language competence and a baseline motivation survey. This allowed the researchers to verify that there were no significant differences between groups in academic ability or learning attitudes ( $p > 0.05$ ). Additionally, demographic data, including age, gender, and prior academic achievement, were collected to confirm group equivalence. External Factors—Both groups learned in classrooms with similar physical conditions (lighting, seating arrangement, learning materials) and identical weekly instructional time. To reduce environmental variability, lessons were conducted at the same time of day for both groups. Teacher Role – The same teacher, trained in conventional and neuropedagogical methods, instructed the experimental and control classes. In the control group, the teacher adhered strictly to traditional methods, while the neuropedagogical model was applied in the experimental group. This approach minimized bias from differing teaching styles or personality effects. Both groups' Lesson plans were standardized regarding learning objectives and content coverage, differing only in instructional approach. These measures were intended to reduce the likelihood that external or pre-existing factors influenced the outcomes, thus strengthening the study's internal validity

The normality of data distribution from the Indonesian language competence test was examined using the Kolmogorov-Smirnov or Shapiro-Wilk test to determine eligibility for parametric analysis. Levene's test was used to assess the homogeneity of variance between the experimental and control groups. When both assumptions were met, independent samples *t*-tests were used to compare motivation and competence; otherwise, the Mann-Whitney test was a non-parametric alternative. In addition to the *t*-test and



normalized gain (n-gain) analysis, effect size was calculated using Cohen's  $d$ , which exceeded 0.80 for both variables, indicating a large practical impact of the neuropedagogical approach. To complement these quantitative results, qualitative feedback from student reflections and informal teacher interviews revealed that the experimental group found the lessons more enjoyable, memorable, and engaging, with noticeable improvements in participation and a reduction in off-task behavior. Combining statistical effect sizes with qualitative insights provided robust empirical evidence and practical perspectives on the effectiveness of the intervention.

## RESULT AND DISCUSSION

In this section, the study's results on the influence of the neuropedagogical approach on the motivation and competence of elementary school students in the Indonesian language will be presented and thoroughly analyzed. Test validity is a crucial first step in ensuring that the instruments used to measure Indonesian language competence and student motivation are accurate and reliable. Content validity was assessed by involving experts in Indonesian language education, and each item in the test was based on the desired measurement objectives. All tests, including reading, writing, speaking, listening, learning motivation, and general skills tests, had high validity coefficients. This indicates that the test instruments used in this study are highly valid and can be trusted to accurately measure Indonesian language skills and students' motivation levels. For example, the writing and speaking tests had validity coefficients of 0.82 and 0.79, respectively, indicating that both effectively measure students' Indonesian language skills. These validity results strongly support efforts to link research findings with the effectiveness of the neuropedagogical approach in improving students' language competence.

**Table 2.**  
Validity test results

No	Type of Test	Validity Coefficient
1	Reading Test	0.75
2	Writing Test	0.82
3	Speaking Test	0.79
4	Listening Test	0.81
5	Motivation Test	0.76
6	General Skills Test	0.78

Based on the results of this validity, the test instrument used has been proven to accurately measure Indonesian language competence and student motivation. Thus, the results of this study are valid and relevant in exploring the influence of the neuropedagogy approach on both variables. Reliability testing was conducted to ensure the consistency of the test results obtained, which is very important for the reliability of the instruments used in this study. Using the Cronbach's Alpha coefficient, the reliability results indicate that the test instrument exhibits a high level of consistency. The Cronbach's Alpha values obtained for the reading test (0.88) and the writing test (0.85) indicate that the tests are highly reliable and can be used consistently to measure Indonesian language competence. This high level of reliability suggests that the instruments used in this study have excellent quality, allowing the data obtained to be relied upon for further analysis.



**Table 3.**  
 Reliability Test Results

No	Type of Test	Cronbach Alpha Value
1	Reading Test	0.88
2	Writing Test	0.85
3	Speaking Test	0.87
4	Listening Test	0.86
5	Motivation Test	0.84
6	General Skills Test	0.83

The Cronbach's Alpha results, greater than 0.80 for all tests, indicate that this test instrument is highly reliable. Thus, the results obtained from this test can be considered stable and consistent, providing a strong foundation for describing the influence of the neuropedagogical approach on Indonesian language competence and student motivation. A normality test was conducted to ensure that the data obtained were normally distributed, a crucial assumption for parametric statistical tests. Based on the results of the Shapiro-Wilk test performed on the distribution of pre-test and post-test scores, it can be concluded that the data obtained for both experimental and control groups were normally distributed. This is reflected in the p-value, which is greater than 0.05 for all groups, indicating that the data do not deviate from the normal distribution. Thus, these results support the use of parametric statistical tests to analyze the data further, particularly the t-test, for comparing the differences between the experimental and control groups.

**Table 4.**  
 Results Of The Normality Test

Group	Test Statistics (Shapiro-Wilk)	Sig. (p-value)
Experiment Pre-test	0.98	0.58
Control Pre-test	0.97	0.63
Experiment Post-test	0.97	0.67
Control Post-test	0.96	0.72

With a p-value greater than 0.05, the data from the experimental and control groups meet the assumption of normality. Therefore, parametric statistical tests, such as t-tests, can be used to compare the differences between the experimental and control groups in a valid manner. The homogeneity test is used to check whether the variance between the two groups is uniform. Levene's test results indicate that the variance between the experimental and control groups is homogeneous, as the p-value obtained is greater than 0.05. This indicates that the assumption of homogeneity is acceptable, meaning that the two groups can be compared without any significant difference in variance.

**Table 5.**  
 Results Of Homogeneity Test

Group	F-Statistic	Sig. (p-value)
Pre-test	1.23	0.27
Post-test	1.15	0.30

The p-value result greater than 0.05 in the Levene test indicates that the variance between the experimental and control groups is homogeneous. Therefore, both groups



have similar characteristics and can be directly compared in subsequent analyses. The distribution of pre-test scores for both groups indicates that, prior to the experimental treatment, both groups had similar levels of Indonesian language competence. The average pre-test score for the experimental group was 55.6, with a standard deviation of 8.12. The control group had a slightly lower average score of 54.9, with a standard deviation of 7.98. This indicates that before the experimental treatment, both groups were at almost the same level of ability, allowing for a fair comparison after applying the neuropedagogical approach.

**Table 6.**  
 Distribution Of Pre-Test Data For Experimental And Control Classes

Group	Mean	Standard Deviation	N
Experiment Pre-test	55.6	8.12	35
Control Pre-test	54.9	7.98	35

There was no significant difference in the pre-test scores between the experimental and control groups, indicating that both groups had almost the same ability level before the experimental treatment was applied. This provides a strong basis for testing the effect of the neuropedagogical approach on students' Indonesian language competence after the treatment. After the experimental treatment, the distribution of post-test scores showed a significant difference between the experimental and control groups. The experimental group showed a significant increase, with an average post-test score of 78.3, while the control group achieved an average score of 56.2. This suggests that the neuropedagogical approach has a greater impact on enhancing students' Indonesian language proficiency than the conventional teaching method applied to the control group.

**Table 7.**  
 Distribution Of Post-Test Data For Experimental And Control Classes

Group	Mean	Standard Deviation	N
Experiment Post-test	78.3	6.91	35
Control Post-test	56.2	7.45	35

The significant difference between the experimental and control groups in the post-test indicates that the neuropedagogical approach was successful in improving students' Indonesian language competence. The experimental group experienced a greater increase, indicating that this approach is more effective than conventional teaching methods. The n-gain test is one method used to measure the effectiveness of changes in the variables tested after the experimental treatment. In this study, the n-gain test is used to measure the extent to which the neuropedagogical approach successfully improved students' Indonesian language competence after the treatment was implemented, both in the experimental and control groups.

**Table 8.**  
 N-Gain Test Results

Group	Mean Pre-test Score	Mean Post-test Score	N-Gain Score	Interpretation of N-Gain
Experimental Group	55.6	78.3	0.76	High
Control Group	54.9	56.2	0.04	Low



The experimental group showed an n-gain of 0.76, which is considered high. This indicates that the application of the neuropedagogy approach significantly improves students' Indonesian language competence. With a high n-gain value, the neuropedagogy approach effectively enhances students' reading, writing, speaking, and listening abilities in Indonesian. In contrast, the control group showed only a n-gain of 0.04, which is considered low. This suggests that, despite following a conventional learning approach, there was no significant improvement in their Indonesian language competence. This low n-gain value suggests that the learning method employed in the control group had a minimal impact on the development of students' language competence.

A t-test was conducted to determine whether the difference between the experimental and control groups in the post-test was statistically significant. The t-test revealed a substantial difference between the two groups, with a very small p-value ( $p < 0.000$ ). This suggests that the neuropedagogy approach has a significant impact on improving students' Indonesian language competence.

**Table 9.**  
T-test Results

Group	t-Statistic	df	Sig. (p-value)
Pre-test vs Post-test	8.52	68	0.000

With a p-value much smaller than 0.05, a significant difference is observed between the experimental and control groups. The neuropedagogical approach has been proven more effective in improving the Indonesian language competence of elementary school students, and substantial t-test results support this finding. Overall, the study's results indicate that the application of the neuropedagogical approach significantly improves the Indonesian language proficiency of elementary school students. This is evidenced by the analysis, which shows that the experimental group experienced a greater increase than the control group, indicating the success of this approach in the context of Indonesian language learning.

**Table 10.**  
Effect Size (Cohen's  $d$ ) for Post-test Scores

Variable	(Experimental)	(Control)	SD Pooled	Cohen's $d$	Effect Size
Language Competence	78.3	56.2	7.20	3.06	Very Large
Learning Motivation	82.5	60.4	6.90	3.19	Very Large

The effect size analysis reveals that the neuropedagogical approach has a significant impact on both language competence ( $d = 3.06$ ) and learning motivation ( $d = 3.19$ ) compared to conventional methods. These values far exceed the 0.80 threshold for a large effect, indicating that the observed improvements are statistically significant and highly meaningful in practical terms. This suggests that the intervention was exceptionally effective in enhancing both linguistic skills and motivational factors. Such strong effects may be attributed to the integration of multisensory activities, movement-based learning, emotional anchoring, and metacognitive reflection, which collectively align with how the brain optimally processes and retains information.



Specifically, the experimental group, which used the neuropedagogy approach, showed a significantly greater increase in motivation and Indonesian language skills compared to the control group, which followed conventional learning methods. The high n-gain in the experimental group, at 0.76, reflects the effectiveness of this approach in improving Indonesian language skills, whereas the control group showed an n-gain of only 0.04, which is very low. This suggests that a brain-based approach, which aligns teaching with how students' brains work, can boost students' intrinsic motivation and significantly improve their language skills.

These results align with previous research findings, indicating that approaches that utilize an understanding of how the brain works can enhance students' motivation and learning skills. For example, research conducted Posner & Rothbart (2023) showed that learning tailored to neurobiological principles can improve learning effectiveness because these methods are based on how the brain processes information. This study's neuropedagogical approach focuses on conventional learning techniques and integrates neuropsychological principles to create more engaging and practical learning experiences. These findings further strengthen the claim that understanding brain function can help design more effective learning methods in improving student learning outcomes, especially in learning Indonesian. Several studies have previously revealed that learning methods that prioritize memorization and written exercises often fail to trigger student motivation, especially in language learning that requires active understanding, application, and communication (Ritonga et al., 2022). In this study, the experimental group taught using a neuropedagogical approach may be more motivated because the strategy focuses on both cognitive and emotional aspects of students, enabling them to learn more effectively.

The results of this study provide an essential contribution to the development of theories in the fields of education and neuropedagogy. Learning theories that have focused on more traditional approaches, which may not adequately consider how students' brains function, can be expanded by introducing a more evidence-based approach from neuroscience (Romero & Pérez, 2021). The neuropedagogical approach to Indonesian language learning opens up new opportunities to understand how language learning can be done in a way that is more in line with how the brain works, thereby increasing students' motivation and improving their language skills (Romios et al., 2020). This study reinforces the notion that teaching based on neuropsychological principles can yield better results in enhancing students' language competence. In the context of learning theory, the results of this study confirm that an approach based on an understanding of how the brain works can improve the quality of learning more effectively than conventional methods that still rely on a more cognitive and structural approach. In this case, this study contributes to the development of brain-based learning theories that can be applied across disciplines in Indonesian language learning and other subjects (Rønning, 2021).

In terms of practice, these findings have significant implications for the world of education, particularly in learning Indonesian at the elementary school level. Schools can consider adopting a neuropedagogical approach in their curriculum, especially to increase students' motivation to learn and their Indonesian language competence (Rubtsov & Ulanovskaya, 2020). This practice also provides recommendations for integrating elements that focus on developing students' cognitive, affective, and social aspects in every learning process. One practical application that can be implemented is the incorporation of digital technology designed to facilitate brain-based learning, such as



educational games or interactive tasks that stimulate students' creativity and active participation (Suyitno et al., 2021). In addition, this study's results indicate that using a neuropedagogical approach that focuses on students' intrinsic motivation can improve the quality of communication and interaction in learning when teaching Indonesian. This approach encourages students to be more active in speaking and writing and improves their ability to understand texts, read, and listen to conversations in Indonesian. Therefore, teachers need to receive appropriate training to effectively apply the principles of neuropedagogy in their teaching practices.

Although the results of this study provide significant contributions to understanding the influence of neuropedagogical approaches on students' motivation and Indonesian language competence, this study also has several limitations that need to be considered in interpreting the results. One of the main limitations is the use of a quasi-experimental design, which did not allow researchers to fully randomize the sample. Although the experimental and control groups were selected randomly, this study design cannot fully control external factors that influence students' motivation and language competence, such as parents' educational background or social environment. Therefore, other variables that cannot be considered in this study may influence the results obtained. Another limitation that needs to be noted is the relatively small sample size, only 70 students divided into two classes. Although this sample is sufficient to show the main trends, a larger and more representative sample of the Indonesian elementary school student population would provide stronger and more generalizable results. Research with a larger sample would also allow for testing wider variations in results across different groups, such as those based on gender, socio-economic background, or students' language proficiency level. Additionally, the study's limited duration, which spanned only a few months, is another limitation that affects the study's results. The influence of the neuropedagogical approach on Indonesian language motivation and competence may require a longer time to be genuinely seen significantly, especially in learning contexts that involve developing skills that take time to master.

Given the limitations of this study, several suggestions for future research can be put forward. First, further research should use a randomized experimental design with larger and more representative control and experimental groups. Research with a more rigorous experimental design will enable a more valid test of the effect of the neuropedagogical approach on Indonesian language competence, providing greater control over external variables that may influence the study's results. Second, long-term research is needed to determine the more profound and sustainable impact of the neuropedagogical approach. Future research should measure student learning outcomes over the long term to see whether the improvements in Indonesian language competence and learning motivation can be maintained over time. Third, research involving a broader population with a wider variety of social, economic, and cultural conditions will provide a more comprehensive picture of the effectiveness of the neuropedagogical approach in various educational contexts. Given the diversity of educational conditions in multiple regions, understanding how this approach can be applied throughout Indonesia will be beneficial. Finally, research integrating digital technology to support the implementation of neuropedagogical principles in learning will be helpful.

The findings of this study have several social and ethical implications that warrant consideration. One of the most critical social implications is the potential for using digital technology in education to improve student learning outcomes, particularly in improving Indonesian language competency among elementary school students. However, it is



essential to remember that technology in education must prioritize equality of access. Not all students have equal access to technology, especially in more remote areas or those with lower economic levels. Therefore, using brain-based technology in learning must be implemented carefully and prioritizes fairness so as not to exacerbate existing educational disparities. From an ethical perspective, special attention must be paid to student data privacy. Digital technology that collects student performance and progress must always be used with due regard for moral principles, including transparency, security, and parental consent. Overall, this study makes a significant contribution to understanding how neuropedagogical approaches can enhance student learning outcomes in the field of Indonesian language education. By considering the social and ethical factors associated with technology and implementing these approaches fairly and responsibly, we can pave the way for a more inclusive and effective education system in the future.

## CONCLUSION

This study demonstrated that the neuropedagogical approach significantly improved Indonesian language competence and learning motivation among elementary school students compared to conventional teaching methods, as evidenced by high *n*-gain values and large effect sizes. Students achieved substantial gains in cognitive and affective domains by aligning instructional strategies with how the brain processes information through multisensory activities, movement integration, emotional anchoring, and metacognitive reflection. These findings suggest that teachers and schools can adopt neuropedagogical principles to create more engaging and effective learning environments. The successful implementation of educational initiatives in various contexts, particularly those with diverse learning needs, may necessitate adjustments to available resources, class sizes, and cultural factors. Potential challenges include teacher readiness, time constraints, and limited access to supportive materials. Therefore, it is recommended that professional development programs include specific training modules, practical lesson plans, and demonstration videos to guide teachers in applying brain-based learning techniques. Curriculum developers could also design supplementary materials and activity banks to facilitate the integration of these lessons into daily instruction.

While the study's results are promising, the small sample size and quasi-experimental design limit the generalizability of findings. Similar results may not necessarily be replicated in schools with vastly different socio-economic or cultural characteristics. Additionally, motivation was measured primarily through self-report surveys, which may be subject to response bias. Future research should employ triangulation methods, such as classroom observations or structured interviews, to capture a more accurate and nuanced picture of student motivation. Longitudinal studies are recommended to examine the long-term sustainability of neuropedagogical effects. Further investigation could explore the integration of neuroscience-based digital applications to enhance student engagement and personalized learning. In addition, qualitative approaches such as in-depth interviews, focus groups, and learner diaries could provide richer insights into how students internalize motivation and develop linguistic competence during neuropedagogical activities.

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