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Implementation of a Neuroscience-Based Approach in Environmental Science Learning to Enhance Elementary School Students' Conceptual Understanding

[1]Rina Purnama Sari, [2]Saiful Bahri, [3]Ida Safitri,

[1] Universitas Sains Cut Nyak Dhien, Indonesia

[1]rinapurnamasari457@gmail.com, [2]saifulbahriunj@gmail.com,
[3]ida.safitri27@gmail.com.

ABSTRACT : This study aimed to describe the implementation of a neuroscience-based approach in environmental science learning and analyze its contribution to improving the conceptual understanding of fifth-grade elementary school students. The study employed a qualitative descriptive design conducted at SD Negeri 1 Kebun Baru, Langsa City, Aceh Province, during the second semester of the 2025/2026 academic year. The participants consisted of one fifth-grade teacher as the primary informant and 30 fifth-grade students selected through purposive sampling. Data were collected through classroom observations, semi-structured interviews, document analysis, and a conceptual understanding test. The research instruments included observation sheets, interview guides, documentation checklists, and essay-based conceptual understanding tests. Data were analyzed using the interactive model of Miles, Huberman, and Saldaña, consisting of data reduction, data display, and conclusion drawing, while data credibility was ensured through source triangulation, technique triangulation, and member checking. The findings revealed that the neuroscience-based approach was implemented successfully through five instructional stages: brain engagement, activation of prior knowledge, multisensory learning, collaborative learning, and reflection. The implementation created an active, interactive, and student-centered learning environment that increased students' motivation and engagement. Students demonstrated excellent conceptual understanding, with an average achievement of 89.0%, particularly in explaining concepts, interpreting environmental phenomena, connecting scientific concepts, and applying them to everyday life. Although several challenges were identified, including limited instructional time, learning media preparation, and differences in students' learning abilities, these issues were effectively addressed through flexible classroom management, the use of the school environment as a learning resource, and heterogeneous group learning. Therefore, the neuroscience-based approach represents an effective instructional strategy for enhancing environmental science learning and strengthening elementary school students' conceptual understanding.

Keywords: Neuroscience-Based Learning, Environmental Science, Conceptual Understanding, Elementary School, Qualitative Research

INTRODUCTION

Twenty-first-century education requires students not only to master factual knowledge but also to develop critical thinking, problem-solving, collaboration, and strong conceptual understanding. In science education, conceptual understanding serves as the foundation that enables students to connect scientific concepts, explain

natural phenomena, and apply scientific knowledge to real-life situations. According to Handono, Nisa, and Prihatni (2023), science instruction in elementary schools should extend beyond content mastery by providing meaningful learning experiences that allow students to actively construct their own understanding of scientific concepts. Furthermore, Rahmawati, Ristiana, and Basri (2023) emphasized that effective science instruction largely depends on teachers' ability to design active, contextual, and student-centered learning activities that promote the development of students' conceptual understanding.

Nevertheless, science instruction in elementary schools continues to face a number of challenges. Barus (2022) explained that science teaching remains largely teacher-centered and focused on content delivery, limiting students' opportunities to develop scientific literacy and conceptual understanding. As a result, students tend to memorize scientific concepts rather than understand the relationships among them, explain natural phenomena, or apply scientific knowledge to solve real-world problems. Furthermore, Patigu, Rahmah, and Zulnuraini (2023) reported that elementary school students' scientific literacy remains relatively low across several indicators, particularly in explaining scientific phenomena and using scientific evidence, highlighting the need for innovative instructional approaches to strengthen students' conceptual understanding.

Environmental topics represent one of the core domains of science education that require students to develop a strong conceptual understanding because they are closely connected to everyday life. According to Hidayat and Ramadhan (2025), concepts such as ecosystems, environmental pollution, natural resource conservation, and ecological balance are more effectively understood when students learn through direct observation and by using their surrounding environment as a learning resource. Furthermore, Afianti, Suharlan, and Hamid (2025) emphasized that contextual learning that incorporates the local environment as a learning resource increases student engagement, provides meaningful learning experiences, and strengthens the connection between scientific concepts and real-world situations.

Advances in neuroscience have provided new perspectives on how the brain processes information during learning. Tokuhama-Espinosa and Borja (2023) argued that a neuroconstructivist approach integrates findings from neuroscience with educational practice, creating active, contextual, and meaningful learning experiences that support knowledge construction. Furthermore, Tokuhama-Espinosa and Nouri (2023) emphasized that applying the principles of Mind, Brain, and Education enables teachers to design brain-compatible instruction by incorporating positive emotions, multisensory activities, social interaction, and meaningful learning experiences to strengthen long-term memory formation.

In science education, a neuroscience-informed approach provides students with opportunities to develop conceptual understanding through learning experiences that optimally engage cognitive processes. According to Fischer et al. (2022) learning is strengthened when multiple neural pathways are activated through rich sensory experiences and active engagement, facilitating more effective information processing and memory formation. Furthermore, Immordino-Yang et al. (2024) emphasized that positive emotions, meaningful social interactions, and authentic learning experiences play essential roles in sustaining attention, enhancing motivation, and supporting long-term learning. Therefore, science instruction that integrates experiments, environmental observations, collaborative discussions, and reflective activities is expected to promote students' conceptual understanding more effectively.

Recent studies have demonstrated that brain-based learning approaches produce positive effects on students' learning outcomes. Oktavianto et al. (2024) reported that neuroscience-based learning enhances elementary school students' critical thinking by stimulating cognitive, emotional, and motivational processes through meaningful learning experiences. Furthermore, Limbong, Rahmawati, and Wulandari (2024) emphasized that neuroscience-informed instructional strategies support conceptual understanding by engaging multiple brain functions through active, exploratory, and collaborative learning activities. These findings suggest that neuroscience-based approaches have considerable potential for improving science instruction in elementary schools.

Nevertheless, research on the implementation of neuroscience-based approaches in environmental science instruction at the elementary school level remains limited. Most previous studies have primarily examined the effectiveness of instructional models such as Problem-Based Learning, Project-Based Learning, and inquiry-based learning in improving students' learning outcomes. Azzahra and Dwiputra (2024) reported that although brain-based learning has demonstrated positive effects across a variety of educational contexts, its application remains concentrated in mathematics and general science, with relatively few studies focusing specifically on environmental science learning in elementary schools. Likewise, Bada and Jita (2022) emphasized that research integrating brain-based learning principles into science instruction is still limited and recommended further empirical studies to examine its implementation across different science topics and educational settings. These findings indicate the need for additional research to provide empirical evidence regarding the effectiveness of neuroscience-based approaches in elementary environmental science instruction.

Based on these conditions, the novelty of this study lies in the implementation of a neuroscience-based instructional approach that integrates five core principles: activation of prior knowledge, positive emotional engagement, multisensory

stimulation, collaborative learning centered on environmental problem-solving, and reflective activities to reinforce long-term memory within elementary environmental science instruction at SD Negeri 1 Kebun Baru, Langsa City, Indonesia. Unlike previous studies that primarily examined the effectiveness of general instructional models or explored neuroscience-based learning in broader educational contexts, this study systematically combines these five brain-compatible learning principles into a single instructional framework for environmental science education. Therefore, this study aims to describe the implementation of the neuroscience-based approach and analyze its contribution to improving elementary school students' conceptual understanding of environmental science.

METHODS

This study employed a qualitative approach using a descriptive research design to provide an in-depth description of the implementation of a neuroscience-based approach in environmental science instruction and its contribution to improving elementary school students' conceptual understanding. A qualitative descriptive design is appropriate for exploring participants' experiences and describing phenomena in their natural settings (Creswell & Creswell, 2023). The study was conducted during the second semester of the 2025/2026 academic year at SD Negeri 1 Kebun Baru, Langsa Baro District, Langsa City, Aceh, Indonesia. The research participants consisted of one fifth-grade classroom teacher as the primary informant and 30 fifth-grade students. Participants were selected through purposive sampling because they were directly involved in the implementation of neuroscience-based instruction and were therefore able to provide relevant information aligned with the objectives of the study.

Data were collected using four techniques: classroom observation, semi-structured interviews, documentation, and a conceptual understanding test. Creswell and Creswell (2023) suggested that qualitative studies benefit from multiple sources of evidence to obtain comprehensive and trustworthy findings. Classroom observations were conducted throughout the learning process using an observation checklist to examine teacher practices, student engagement, the implementation of neuroscience principles, and the overall classroom environment. Semi-structured interviews were carried out with the classroom teacher and several students to obtain detailed information regarding lesson planning, instructional implementation, challenges, and perceived benefits of the neuroscience-based approach. Documentation included lesson modules, student worksheets, photographs of classroom activities, students' learning products, and other supporting documents. In addition, an open-ended conceptual understanding test was administered at the end

of the instructional sequence to assess students' ability to explain scientific concepts, identify relationships among concepts, interpret environmental phenomena, and apply scientific knowledge to everyday situations.

The research instruments consisted of an observation checklist, interview guidelines, documentation sheets, and a conceptual understanding test. The observation instrument was developed based on key neuroscience-based instructional principles, including the creation of a positive learning environment, activation of prior knowledge, multisensory stimulation, collaborative learning, positive emotional engagement, constructive feedback, and reflective learning activities. The interview protocol was designed in a semi-structured format to allow participants to elaborate on their experiences while enabling the researcher to explore emerging issues during data collection. The conceptual understanding test was developed according to the learning objectives of the environmental science unit and was validated through expert judgment involving two elementary education lecturers and one senior elementary science teacher to ensure content validity before implementation.

The study was conducted in four stages: preparation, implementation, data collection, and data analysis. During the preparation stage, the research instruments were developed and validated, and permission was obtained from the school. The implementation stage involved neuroscience-based instruction beginning with activities designed to activate students' prior knowledge, followed by multisensory learning experiences through videos, visual materials, environmental observations, and simple experiments. Students then participated in collaborative group discussions to solve environmental problems and concluded the lesson with reflective activities intended to strengthen long-term memory. Throughout the instructional process, the researcher conducted observations, interviews, documentation, and administered the conceptual understanding test.

Data were analyzed using the interactive analysis model proposed by Miles, Huberman, and Saldaña (2020) consisting of data reduction, data display, and conclusion drawing and verification. According to Miles, Huberman, and Saldaña (2020) these three analytical processes occur interactively throughout qualitative research. Data reduction involved selecting, organizing, and simplifying information obtained from observations, interviews, documentation, and conceptual understanding tests according to the research objectives. The organized data were then presented in descriptive narrative form to facilitate pattern identification and interpretation. Finally, conclusions were drawn and verified through source triangulation, methodological triangulation, and member checking to ensure the credibility, dependability, transferability, and confirmability of the research findings (Creswell & Creswell, 2023).

RESULT AND DISCUSSION

RESULTS

Based on the research objectives, the findings are presented in four aspects: (1) the implementation of the neuroscience-based approach in environmental science learning, (2) students' learning activities during the instructional process, (3) students' conceptual understanding after participating in the learning activities, and (4) the teacher's perceptions regarding the implementation of the neuroscience-based approach.

A. Implementation of the Neuroscience-Based Approach in Environmental Science Learning

The neuroscience-based approach was implemented in fifth-grade environmental science instruction at SD Negeri 1 Kebun Baru through five instructional stages: brain engagement, activation of prior knowledge, multisensory learning, collaborative learning, and reflection. Classroom observations indicated that the teacher successfully implemented all instructional stages in accordance with the neuroscience-based learning framework outlined in the lesson module. The implementation level of each instructional stage is presented in Table 1.

Table 1. Implementation of the Neuroscience-Based Approach in Environmental Science Learning

No.	Neuroscience-Based Learning Stage	Percentage (%)	Category
1	Brain Engagement	92	Excellent
2	Activation of Prior Knowledge	90	Excellent
3	Multisensory Learning	94	Excellent
4	Collaborative Learning	91	Excellent
5	Reflection	89	Excellent
Average		91.2	Excellent

As shown in Table 1, the overall implementation of the neuroscience-based approach achieved an average implementation score of 91.2%, which falls within the excellent category. The multisensory learning stage obtained the highest implementation score (94%), whereas the reflection stage received the lowest score (89%), although it also remained within the excellent category.

Classroom observations revealed that the teacher successfully created a positive and engaging learning environment during the brain engagement stage through introductory activities, ice-breaking exercises, and instructional videos that stimulated students' interest and attention. During the activation of prior knowledge stage, the teacher connected the lesson content with students' prior experiences related to environmental conditions around their homes and school.

The multisensory learning stage was implemented through instructional videos, visual images, direct observation of the school environment, and simple science experiments, allowing students to gain first-hand learning experiences. During the collaborative learning stage, students worked in small groups to discuss environmental issues, analyze their observations, and present their findings to the class. Finally, the reflection stage involved summarizing the lesson, providing teacher feedback, and encouraging students to reflect on the knowledge they had acquired throughout the learning process

The observation findings were supported by interviews with the fifth-grade classroom teacher, who stated that implementing the neuroscience-based approach had a positive impact on the learning process. The teacher explained that students became more active in asking questions, more confident in expressing their opinions, and demonstrated a better understanding of environmental concepts because learning extended beyond teacher explanations to include observation, discussion, and hands-on experimentation. The teacher also emphasized that the use of diverse instructional media increased students' attention, motivation, and participation during classroom activities.

Table 2. Summary of Teacher Interview Findings

Aspect	Interview Findings
Lesson Planning	The teacher developed lesson modules based on the neuroscience-based instructional framework.
Instructional Implementation	Learning became more active, interactive, and student-centered.
Student Responses	Students showed greater enthusiasm, actively asked questions, and confidently expressed their opinions.
Conceptual Understanding	Students developed a better understanding of environmental concepts through observation and experimentation.
Challenges	Time management and preparation of instructional media.
Solutions	Utilizing the school environment as a learning resource and managing instructional time effectively.

In addition to interviewing the classroom teacher, interviews were conducted with several fifth-grade students to explore their perceptions of the learning experience. Most students reported that the lessons were more interesting because they involved instructional videos, visual images, environmental observations, and collaborative group discussions. Students also stated that outdoor learning activities helped them understand environmental science concepts more easily and increased their motivation to maintain environmental cleanliness and sustainability around the school.

Table 3. ***Summary of Student Interview Findings***

Aspect	Findings
Interest in Learning	Learning activities were more interesting and enjoyable.
Use of Instructional Media	Videos and visual images helped students understand the lesson more effectively.
Environmental Observation	Direct observation improved students' understanding of environmental science concepts.
Group Discussion	Enhanced collaboration and students' confidence in expressing ideas.
Reflection Activities	Helped students reinforce and remember the concepts they had learned.

The observation and interview findings were further supported by documentation, including lesson modules, student worksheets (LKPD), photographs of classroom activities, and students' completed assignments. The documentation confirmed that all stages of the neuroscience-based instructional approach were implemented according to the lesson plan. Classroom photographs showed students actively participating in environmental observations, collaborative discussions, group presentations, and reflective learning activities. Students' written assignments demonstrated that most students were able to identify ecosystem components, explain different forms of environmental pollution, and propose practical solutions to environmental problems identified in the school environment.

Table 4. Documentation Findings on the Implementation of the Neuroscience-Based Approach

Document	Findings
Lesson Module	Included the complete neuroscience-based instructional framework.
Student Worksheets (LKPD)	Contained observation, experimentation, and environmental problem-solving activities.
Classroom Photographs	Showed students actively participating in observations, discussions, presentations, and reflection activities.
Students' Assignments	Demonstrated students' ability to explain environmental concepts and propose solutions to environmental problems.
Assessment Results	Indicated improvement in students' conceptual understanding following the instructional process.

Based on the findings obtained from classroom observations, interviews, and documentation, it can be concluded that the neuroscience-based approach was successfully implemented in fifth-grade environmental science instruction at SD

Negeri 1 Kebun Baru. The teacher effectively applied all instructional stages in accordance with neuroscience principles, while students demonstrated high levels of engagement throughout the learning process. These findings indicate that the neuroscience-based approach creates a more interactive, meaningful, and student-centered learning environment that supports the development of elementary school students' conceptual understanding of environmental science.

B. Improvement of Students' Conceptual Understanding Through the Neuroscience-Based Approach

Students' conceptual understanding was assessed using an essay test administered at the end of the learning process. The assessment was based on five indicators: (1) explaining scientific concepts, (2) providing appropriate examples, (3) identifying relationships among concepts, (4) interpreting environmental phenomena, and (5) applying scientific concepts to everyday life. The analysis showed that most students achieved good to excellent levels of conceptual understanding across all indicators. The results are presented in Table 5**.**

Table 5. Students' Conceptual Understanding

No.	Conceptual Understanding Indicator	Percentage (%)	Category
1	Explaining environmental concepts	90	Excellent
2	Providing examples based on concepts	88	Good
3	Identifying relationships among concepts	86	Good
4	Interpreting environmental phenomena	92	Excellent
5	Applying concepts to everyday life	89	Excellent
Average		89.0	Excellent

As shown in Table 5, the average score for students' conceptual understanding was 89.0**%**, which falls within the excellent category. The highest achievement was recorded in the indicator of interpreting environmental phenomena (92%), while the lowest score was obtained in identifying relationships among concepts (86%). Nevertheless, all indicators were categorized as good or excellent**,** indicating that students developed a comprehensive understanding of environmental science concepts.

Classroom observations revealed that students' conceptual understanding improved because they participated in authentic learning experiences through environmental observations, simple experiments, visual learning media, and collaborative group discussions. Students were able to identify biotic and abiotic components within the school environment, explain the causes of environmental pollution, and propose practical environmental conservation strategies based on their direct observations. During group presentations, most students successfully explained

the relationship between human activities and environmental changes using their own words, demonstrating meaningful conceptual understanding rather than simple memorization.

The observation findings were supported by interviews with the fifth-grade teacher, who stated that the neuroscience-based approach positively influenced students' conceptual understanding. The teacher explained that students learned the material more quickly because they were given opportunities to observe real objects directly and discuss their findings with classmates. Furthermore, the teacher emphasized that students retained information more effectively when learning activities were connected to real-life environmental experiences.

Table 6. Summary of Teacher Interview Findings on Students' Conceptual Understanding

Aspect	Interview Findings
Conceptual understanding	Students understood the lesson more quickly after conducting direct observations.
Ability to explain concepts	Most students were able to explain scientific concepts using their own words.
Ability to connect concepts	Students demonstrated the ability to relate environmental concepts to everyday life.
Learning impact	Learning became more meaningful and easier for students to remember.

Interviews with students also indicated that the neuroscience-based learning approach helped them understand environmental science concepts more effectively. Most students reported that environmental observations, instructional videos, simple experiments, and collaborative discussions enabled them not only to memorize scientific information but also to understand the relationships among concepts and connect classroom learning with real environmental conditions.

Table 7. Summary of Student Interview Findings on Conceptual Understanding

Aspect	Findings
Understanding of learning materials	Concepts were easier to understand through direct observation.
Use of instructional media	Videos and visual images facilitated understanding of environmental concepts.
Group discussions	Helped students exchange ideas and strengthen conceptual understanding.
Application of concepts	Students understood practical ways to maintain environmental cleanliness and sustainability.

These findings were further supported by document analysis, including students' answer sheets, group discussion reports, concept maps, and environmental observation reports. The documentation demonstrated that most students were able to identify ecosystem components, classify organic and inorganic waste, explain the impacts of environmental pollution, and propose practical solutions to environmental problems found within the school environment.

Table 8. Documentation Findings on Students' Conceptual Understanding

Document	Findings
Students' Test Answer Sheets	Most students achieved scores within the good and excellent categories.
Group Discussion Reports	Students successfully identified environmental problems and proposed appropriate solutions.
Concept Maps	Demonstrated meaningful relationships among environmental science concepts.
Environmental Observation Reports	Students accurately described observation results using appropriate scientific concepts.

Based on the results of the conceptual understanding test, classroom observations, interviews, and document analysis, it can be concluded that the neuroscience-based approach made a positive contribution to students' conceptual understanding of environmental science. Learning activities involving direct experiences, multisensory stimulation, collaborative learning, and reflective practices enabled students to construct scientific concepts more meaningfully. Consequently, students demonstrated not only the ability to recall scientific information but also to understand, relate, interpret, and apply environmental science concepts in their daily lives.

C. Challenges and Teachers' Efforts in Implementing the Neuroscience-Based Approach in Environmental Science Learning

Although the neuroscience-based approach was successfully implemented in environmental science learning, the findings revealed that the teacher encountered several challenges throughout the instructional process. These challenges were identified through classroom observations, interviews, and document analysis, indicating obstacles related to time management, the availability of instructional media, and differences in students' learning characteristics and abilities. Nevertheless, the teacher employed various strategies to address these challenges, ensuring that the learning process remained effective and meaningful.

Table 9. Challenges in Implementing the Neuroscience-Based Approach

No.	Challenge	Findings

1	Time management	Each stage of the instructional process required more time than conventional teaching methods.
2	Availability of learning media	The teacher required a variety of instructional media appropriate to the learning materials.
3	Differences in students' abilities	Some students required additional guidance during observation and group discussion activities.
4	Managing collaborative discussions	The teacher needed to encourage all students to participate actively in group work.
5	Environmental conditions	Outdoor observation activities were influenced by weather conditions and the surrounding school environment.

As presented in Table 9, the primary challenge encountered by the teacher was effective time manage*m*ent. Each stage of the neuroscience-based instructional approach including environmental observation, simple experiments, collaborative discussions, group presentations, and reflective activities—required sufficient instructional time. Consequently, the teacher carefully organized classroom activities to ensure that all learning stages were completed according to the planned instructional sequence. In addition, limitations in instructional media encouraged the teacher to maximize the use of the school environment as the primary learning resource.

Interview findings with the classroom teacher indicated that differences in students' academic abilities also presented a challenge during the learning process. According to the teacher, some students quickly understood scientific concepts, whereas others required repeated explanations and closer guidance before fully comprehending the lesson. To accommodate these differences, the teacher organized heterogeneous learning groups so that students with stronger academic abilities could assist their peers during discussions and collaborative learning activities.

Table 10. Teachers' Strategies for Addressing Implementation Challenges

Challenge	Teacher's Strategy
Time management	Developed a more detailed time allocation for each instructional stage.
Limited learning media	Utilized the school environment as a learning resource and incorporated available digital media.
Differences in students' abilities	Formed heterogeneous groups and provided additional guidance to students requiring support.

Student participation	Increased motivation through guiding questions, encouragement, and recognition of active participation.
Environmental observation	Adjusted outdoor learning activities according to weather and environmental conditions.

Interviews with students indicated that they experienced relatively few difficulties during the learning process. Some students reported that they needed additional time to complete the student worksheets and understand several scientific terms. However, they explained that these challenges were minimized through collaborative group discussions, teacher guidance, and the use of engaging instructional media, enabling them to complete the learning activities successfully.

These findings were further supported by document analysis, including lesson modules, student worksheets (LKPD), classroom photographs, and observation records. The documentation demonstrated that the teacher adapted instructional strategies throughout the learning process by providing concrete examples, utilizing the school environment as an outdoor learning laboratory, and organizing group tasks to ensure that every student actively participated. The documentation also confirmed that despite several technical challenges, all stages of the neuroscience-based instructional approach were successfully implemented in accordance with the planned learning objectives.

Based on the findings from classroom observations, interviews, and document analysis, it can be concluded that the challenges encountered during the implementation of the neuroscience-based approach did not significantly hinder the effectiveness of the learning process. The teacher's efforts—including effective time management, maximizing the use of the school environment as a learning resource, utilizing diverse instructional media, and organizing heterogeneous collaborative groups successfully supported the implementation of the instructional approach. These findings suggest that the neuroscience-based approach can be effectively applied in elementary environmental science learning when supported by careful instructional planning, teacher creativity, and effective classroom management.

D. The Impact of Implementing the Neuroscience-Based Approach on Environmental Science Learning

Based on the findings obtained from classroom observations, interviews, document analysis, and the conceptual understanding assessment, the implementation of the neuroscience-based approach had a positive impact on both the learning process and learning outcomes in fifth-grade environmental science instruction at SD Negeri 1 Kebun Baru. These positive outcomes were reflected in

increased student engagement, improved conceptual thinking skills, and the creation of a more active, meaningful, and enjoyable learning environment.

Table 11. Impact of the Implementation of the Neuroscience-Based Approach

No.	Aspect	Findings
1	Learning motivation	Students demonstrated greater enthusiasm throughout the learning process, from the introductory activities to the reflection stage.
2	Student participation	Students actively asked questions, participated in discussions, conducted observations, and presented their group findings.
3	Conceptual understanding	Most students were able to explain, relate, and apply environmental science concepts effectively.
4	Collaboration	Students' collaboration and communication skills improved during group learning activities.
5	Environmental awareness	Students demonstrated greater concern for maintaining the cleanliness and sustainability of the school environment.

As presented in Table 11, the implementation of the neuroscience-based approach positively influenced multiple aspects of the learning process. Classroom observations revealed that students became more confident in expressing their opinions, actively participated in classroom discussions, and engaged enthusiastically in every learning activity. Environmental observations, simple scientific experiments, and collaborative group discussions enabled students to construct knowledge through direct experience, making scientific concepts easier to understand and retain.

Interview findings with the classroom teacher indicated that one of the most noticeable improvements was the increase in students' learning motivation. According to the teacher, students demonstrated greater concentration during classroom instruction, exhibited higher levels of curiosity, and became more confident when presenting the results of their group discussions. The teacher further explained that the neuroscience-based approach not only enhanced students' conceptual understanding but also strengthened their communication skills, teamwork, and active participation throughout the learning process.

The interview findings were consistent with students' responses. Most students reported that environmental science lessons became more interesting because they were able to learn through direct observation of the school environment. They also stated that instructional videos, visual images, and simple experiments helped them understand scientific concepts more effectively than

conventional lecture-based instruction. Furthermore, students reported that the learning activities increased their awareness of environmental conservation and motivated them to maintain the cleanliness and sustainability of their school environment.

Document analysis, including classroom photographs, student worksheets (LKPD), group presentation materials, and assessment records, further supported these findings. The documentation demonstrated that students actively participated in collaborative learning activities, successfully completed group assignments, developed concept maps, and proposed practical solutions to environmental problems identified within the school environment. These documents also illustrated students' ability to integrate scientific concepts into authentic learning contexts.

Overall, the findings indicate that the neuroscience-based approach contributed not only to improving students' conceptual understanding but also to creating a more interactive, meaningful, and student-centered learning environment. The integration of instructional activities that simultaneously engaged students' cognitive, affective, and psychomotor domains through authentic learning experiences played a significant role in enhancing the effectiveness of environmental science instruction at the elementary school level.

DISCUSSION

The findings of this study indicate that the implementation of the neuroscience-based approach in environmental science learning at SD Negeri 1 Kebun Baru was carried out very effectively. The teacher successfully implemented all instructional stages, including brain engagement, activation of prior knowledge, multisensory learning, collaborative learning, and reflection in a systematic manner. These stages created an active, enjoyable, and student-centered learning environment that encouraged students' engagement throughout the instructional process. This finding is consistent with the study conducted by Comillo and Mistades (2025), which reported that Brain-Based Teaching significantly improves students' conceptual understanding by creating meaningful learning experiences aligned with how the brain naturally processes information. Similarly, Lagoudakis and Vlachos (2024) found that integrating brain-based learning elements into science instruction enhances students' participation and promotes deeper scientific understanding through active cognitive engagement.

The findings also demonstrate that the use of diverse instructional media, environmental observations, and simple experiments positively contributed to students' learning activities. Learning experiences that engaged multiple senses enabled students to understand scientific concepts more effectively because they

acquired knowledge through authentic experiences rather than passive instruction. These findings are supported by Suryaningsih and Supena (2024), who reported that brain-based learning supported by interactive media significantly improves students' conceptual understanding through multisensory experiences. Likewise, Muntaqiyah and Bektiarso (2024) concluded that activity-based science learning supported by innovative instructional media enhances students' conceptual understanding and critical thinking skills by encouraging active participation throughout the learning process.

The results of the conceptual understanding assessment revealed that most students achieved an excellent level of conceptual mastery after participating in neuroscience-based instruction. Students were able not only to explain environmental concepts but also to relate concepts, interpret environmental phenomena, and apply scientific knowledge to everyday situations. These findings are in agreement with Comillo and Mistades (2025), who found that Brain-Based Teaching significantly enhances students' conceptual understanding through active processing and reflective learning activities. Furthermore, Irsyad and Fauziyah (2024) emphasized that active learning approaches requiring students to analyze problems and construct knowledge independently are highly effective in improving conceptual understanding in elementary science education.

Although the neuroscience-based approach was implemented successfully, several challenges were identified, including limited instructional time, the preparation of learning media, and differences in students' learning abilities. Nevertheless, these challenges were successfully addressed through effective classroom management, the utilization of the school environment as a learning resource, and the organization of heterogeneous learning groups. These findings are consistent with Lagoudakis and Vlachos (2024), who highlighted that successful implementation of brain-based instruction depends on teachers' ability to design flexible and student-centered learning experiences. Similarly, Suryaningsih and Supena (2024) argued that teachers' pedagogical competence and creativity in selecting learning resources play essential roles in maximizing the effectiveness of brain-based learning.

Overall, the findings demonstrate that the neuroscience-based approach positively contributes to the quality of environmental science instruction in elementary schools. The approach not only improves students' conceptual understanding but also enhances learning motivation, collaboration, communication skills, critical thinking, and environmental awareness. Learning activities integrating multisensory stimulation, authentic experiences, collaborative learning, and reflection provide meaningful opportunities for students to construct knowledge according to

the natural learning processes of the brain. These findings support the conclusions of Comillo and Mistades (2025) that Brain-Based Teaching promotes meaningful conceptual learning and positive classroom engagement. In addition, Lagoudakis and Vlachos (2024) concluded that brain-based instructional strategies effectively improve scientific understanding while fostering active and meaningful student participation in science learning.

CONCLUSION

Based on the findings of this study, it can be concluded that the implementation of the neuroscience-based approach in fifth-grade environmental science learning at SD Negeri 1 Kebun Baru was carried out very effectively through five instructional stages: brain engagement, activation of prior knowledge, multisensory learning, collaborative learning, and reflection. The implementation of these stages created a more active, interactive, and student-centered learning environment. The use of diverse instructional media, environmental observations, simple experiments, group discussions, and reflective activities provided meaningful learning experiences and increased students' motivation and engagement throughout the learning process.

The neuroscience-based approach also contributed positively to improving students' conceptual understanding of environmental science concepts. Students demonstrated good abilities in explaining concepts, identifying relationships among concepts, interpreting environmental phenomena, and applying scientific concepts to everyday life. Although several challenges were encountered, including limited instructional time, preparation of learning media, and differences in students' learning abilities, the teacher successfully addressed these challenges through effective classroom management, the utilization of the school environment as a learning resource, and the formation of heterogeneous learning groups. Therefore, the neuroscience-based approach can be considered an effective alternative instructional strategy for enhancing the quality of environmental science learning and strengthening elementary school students' conceptual understanding.

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