Implementation of Deep Learning for Strengthening Reading Literacy in Elementary School

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Abstract

Keywords:
Deep Learning;
Learning;
Elementary school;
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This paper aims to explore the application of deep learning to strengthen reading literacy in elementary school learning. This research was conducted in natural and social science learning in grade IV of SDN 2 Ringinanom Ponorogo. The researcher used a qualitative case study approach with data collection techniques using interviews, observations, and documentation studies. The researcher used interactive data analysis by Miles, Huberman, and Saldana which included data reduction, data presentation, and verification and drawing conclusions. The results of the study showed that reading literacy was strengthened through several aspects, namely finding and accessing information, interpreting and integrating, and evaluating and reflecting. Deep learning is carried out by integrating three main principles, namely meaningful learning, mindful learning, and joyful learning. The application of deep learning has an impact on improving learning outcomes and student involvement in learning. These findings offer pedagogical innovations that focus on developing knowledge, skills, and reading literacy in elementary school.

Abstrak

Kata Kunci:
Deep Learning;
Pembelajaran;
Sekolah Dasar;
Kurikulum Merdeka.

Tulisan ini bertujuan untuk mengeksplorasi penerapan *deep learning* untuk penguatan literasi membaca pada pembelajaran di sekolah dasar. Penelitian ini dilakukan pada pembelajaran ilmu pengetahuan alam dan sosial di kelas IV SDN 2 Ringinanom Ponorogo. Peneliti menggunakan pendekatan kualitatif studi kasus dengan teknik pengumpulan data menggunakan wawancara, observasi, dan studi dokumentasi. Peneliti menggunakan analisis data interaktif oleh Miles, Huberman, dan Saldana yang meliputi reduksi data, penyajian data, dan verifikasi serta penarikan simpulan. Hasil penelitian menunjukkan bahwa literasi membaca dikuatkan melalui beberapa aspek yaitu menemukan dan mengakses informasi, menginterpretasi dan mengintegrasi, serta mengevaluasi dan merefleksi. *Deep learning* dilakukan dengan mengintegrasikan tiga prinsip utama, yaitu pembelajaran bermakna, berkesadaran, dan menyenangkan. Penerapan *deep learning* memberikan dampak pada peningkatan hasil belajar dan keterlibatan siswa dalam pembelajaran. Temuan ini menawarkan inovasi pedagogis yang berfokus pada pengembangan pengetahuan, keterampilan, dan literasi membaca di sekolah dasar.

INTRODUCTION

Deep learning in the context of education can be interpreted as a learning approach that focuses on deep understanding, not just superficial mastery of information or mere memorization. This approach is based on the awareness that the challenges of 21st-century education are no longer adequately answered by conventional methods that only emphasize narrow cognitive aspects (Kemendikdasmen, 2025). On the contrary, deep learning emphasizes the creation of a conscious learning process, meaningful learning, and joyful learning (Wathon, 2024). This means that students are not only required to understand the subject matter but are also involved emotionally, socially, and physically in their learning experiences.

Furthermore, this approach is designed to stimulate the development of students' full potential through four main dimensions, namely thinking (intellectual aspects), heart processing (ethical and moral aspects), feeling (aesthetic and emotional aspects), and sports (kinesthetic and physical aspects). Each of these dimensions does not stand alone but is integrated with each other to create holistic and contextual learning (Goyal et al., 2018; Putri et al., 2024). This approach is very relevant in facing the challenges of today's world which is marked by very rapid, complex, and uncertain changes. Education no longer only acts as a medium for transferring knowledge but must be able to equip students with the competencies needed for the future such as critical thinking, collaboration, and innovation in various situations (Cahyanto et al., 2024; OECD, 2018).

Thus, deep learning is not just a matter of developing learning strategies, but is related to the philosophy of education that places students as active subjects in the learning process. Therefore, the integration of deep learning principles in learning, especially at the elementary school level, is a strategic step in building the foundation of future education that is oriented towards humanity (Ahmad et al., 2019; Juarminson, 2021). The application of deep learning is not only aimed at improving students' understanding of the subject matter, but also an effort to change the way students learn, think, and interact in the learning process. This approach also shifts the learning paradigm from teacher-centered to a more active, participatory, and collaborative model.

In traditional learning, the learning process often focuses on mastering information mechanically through memorization and repetition. Students are placed as passive recipients of information, so there is not much room for exploration, creativity, or application of knowledge in real contexts (LeCun et al., 2015; Mathew et al., 2021). In contrast, deep learning places students as the main actors in the learning process. Students are invited to dig deeper into the subject matter, connect the concepts learned,

and reflect on the meaning of learning to their lives, encouraging students to ask questions, discuss, work together, and solve problems collaboratively (Janiesch et al., 2021).

In addition, deep learning provides greater space for the integration of students' values, experiences, and emotions in the learning process, making it more relevant, contextual, and awareness-raising. When students can relate what they learn to the realities of their lives, learning becomes more meaningful and sustainable (Shinde & Shah, 2018). This is in line with the 21st century educational approach that demands the development of essential competencies such as creative thinking, cross-disciplinary collaboration, effective communication, and adaptability. On the other hand, deep learning also refers to a learning process that emphasizes deep understanding and the relationship between conceptual and procedural knowledge, including the ability to apply that knowledge in various new contexts (Hattie & Donoghue, 2016). Among its main characteristics is the acquisition of knowledge based on experience where students learn not only from what is taught, but also from direct involvement in activities that encourage exploration, reflection, and real application (Perrotta & Selwyn, 2020; Smith & Colby, 2007).

Moreover, deep learning is a philosophical and pedagogical framework based on three main principles that are interrelated and mutually reinforcing, namely meaningful learning, mindful learning, and joyful learning. These three principles are the foundation for creating meaningful learning experiences that emphasize the importance of the relationship between subject matter and the reality and life experiences of students (Fullan et al., 2024). Meanwhile, mindful learning requires full attention, mental involvement, and reflection in the learning process. Meanwhile, joyful learning creates a pleasant learning atmosphere that ultimately motivates students to be more active and involved in the learning process (Kemendikdasmen, 2025). Elementary school is a fundamental stage in a child's educational journey that plays a crucial role in shaping students' cognitive, affective, and social foundations.

At this time, students are in a phase of rapid development which is often referred to as the golden age where curiosity, imagination, and thinking skills begin to develop well (Cahyanto et al., 2024). Therefore, appropriate pedagogical interventions at this level have great potential in shaping students' ways of thinking, attitudes, and character. In this context, the application of deep learning is very relevant to encourage students to understand concepts in depth. This study focuses on exploring the application of the deep learning approach in science learning in an effort to strengthen reading literacy in grade

IV of SDN 2 Ringinanom Ponorogo. The location of this study was chosen because it is one of the schools that has implemented deep learning sustainably. This study is expected to not only provide academic contributions but also present best practices that can be adapted by other institutions, especially in the context of learning natural and social sciences and the application of deep learning at the elementary school level.

METHOD

This study uses a qualitative approach with a case study type, as explained by Creswell (2007) who emphasizes the importance of direct involvement of researchers in real-life contexts in order to gain a deep understanding of contemporary phenomena in a specific situation. The case study was chosen because it provides an opportunity to thoroughly explore the implementation of the deep learning approach in class IV of SDN 2 Ringinanom Ponorogo and explore its impact on learning outcomes and student engagement in learning (Denzin & Lincoln, 2011). In accordance with the views of Baxter & Jack (2008) & Yin (2017) in this study, data was collected through various techniques such as interviews, observations, and documentation. The main focus in data collection lies in in-depth interviews with key informants, namely the principal, class teachers, and students.

The interviews were designed to explore the views of stakeholders regarding the implementation of the deep learning approach and its impact on science learning outcomes in grade IV class. In addition, the researcher also conducted a review of supporting documents relevant to the focus of this research and direct observation of the learning process in the classroom to obtain a real picture of the implementation of the approach as well as its impact on student outcomes and involvement in learning (Frost, 2011; Taylor et al., 2016). Through this approach, this research is expected to provide a significant contribution in enriching the understanding of the application of deep learning in the context of learning in elementary schools. Details of interview data collection techniques are presented in Table 1 below, which contains the coding of informants involved in this study.

Code	Sources	Description
RPT-Interview.HM.01	School Headmaster	Data on education policies, support and vision: a. School vision and mission related to strengthening literacy and deep learning b. School policies in supporting learning c. Support and facilitation for teachers in implementing the deep learning approach (training, facilities, and coaching) d. Managerial challenges in implementing learning innovations
RPT-Interview.TC.01 RPT-Interview.TC.02 RPT-Interview.TC.03	Classroom teacher	Data on learning practices, strategies, and challenges: a. Planning, implementation, and evaluation of learning with a deep learning approach b. Teacher strategies in guiding students to understand, apply, and reflect on learning c. Teacher experience in building student engagement during learning d. Cognitive, affective, and social development of students during the learning process e. Obstacles or challenges faced by teachers in learning
RPT-Interview.ST.01 RPT-Interview.ST.02	Grade IV students	Data on students' learning experiences, motivation, and perceptions: a. Students' experiences during learning b. Students' perceptions of learning strategies implemented by teachers c. Students' involvement and enthusiasm during learning activities d. Difficulties or challenges faced in learning e. Students' expectations of the learning process in class

Table 1. Coding informants in interview data collection techniques

To ensure the validity of the findings, this study follows the stages of data analysis as described by Miles et al. (2014) which include the process of data reduction, data presentation, and verification and drawing conclusions. Data reduction is carried out through the process of filtering, grouping, and eliminating irrelevant information so that only data that is in accordance with the research objectives is analyzed further. The data presentation stage functions to organize the findings so that the relationship patterns in the data can be seen clearly and facilitate the analysis process. Meanwhile, the verification and drawing conclusions stage is carried out by examining the relationships, similarities, and differences in the data, in order to gain a deeper understanding. The validity of the conclusions is strengthened through a review of accurate evidence as suggested by Davies & Dodd (2002) & Miles & Huberman (1994) in order to maintain the credibility of the research results.

RESULTS AND DISCUSSION

Based on the results of the research that has been conducted, the researcher has successfully identified a number of interesting findings to be revealed and analyzed further. These findings emerged from the results of interviews, documentation, and observations during the research activities that took place contextually. These findings provide an important picture of the application of the deep learning approach and its impact on learning outcomes and student engagement in learning. To facilitate understanding and further review, the results of the research are presented systematically based on the main themes that emerged during the data analysis process. The results of this study are as follows.

Application of Deep Learning in Learning

The results of the study conducted in class IV of SDN 2 Ringinanom Ponorogo showed that the implementation of the deep learning approach had been carried out by integrating three main principles, namely meaningful learning, mindful learning, and joyful learning. These three principles have been proven to be able to create a deep learning experience and empower students during the learning process in the classroom. In implementing learning in the Natural and Social Sciences (IPAS) subject, teachers apply a deep learning approach through meaningful learning strategies that are directly linked to the contextual conditions of students. The topic raised in the learning is "My Region and its Natural Resources" which provides space to connect conceptual knowledge with the real context around students. The more detailed design and description of this learning can be seen in Table 2 below.

Learning Outcomes	Learning Objectives	Reading Literacy Aspects
• Students identify the variety of landscapes and their relationship to community professions. • Students describe biodiversity, geographical location, and conservation efforts.	• Students can identify the types of food crops that are dominant in their area by linking the geographical location of the residential area and the existing biodiversity. • Students can design and make simple processed products from corn harvests in groups as a form of utilizing agricultural products and strengthening life skills. • Students can explain the importance of maintaining the sustainability of natural resources through environmentally friendly agricultural product processing practices (corn), such as minimizing waste, using local materials, and documenting the	• Finding and accessing information (Finding explicit information in the text and selecting relevant information in the text) • Interpreting and integrating (Interpreting implicit information in the text and drawing conclusions and making connections) • Evaluating and reflecting (Assessing the quality and credibility of the text and reflecting on the content of the text that is associated

process in the form of project reports.	with everyday life experiences)

Table 2. Description of learning design

Learning begins by exploring students' initial knowledge about the potential of natural resources in the surrounding environment such as rice fields and gardens. Students are invited to identify various types of natural resources such as rice, cassava, and corn. The teacher uses concrete learning media in the form of map images and short videos about natural resources around students. The teacher also uses examples of natural products around students to provide concrete knowledge to students. The teacher invites students to analyze how the natural resources around them are very diverse and can be processed into creative products of high value (Beattie et al., 1997; Kovac et al., 2025). As conveyed by the following teacher.

> P1: "...The meaningfulness of learning in my opinion is the main key to achieving the real learning goals. In the deep learning approach that I apply in class, I always try to invite students to see directly how the material they are learning is relevant to their daily lives. So it's not just about understanding the contents of the book, but also relating it to what they experience, see, or feel around them."

> P2: "...For example, when learning about natural resources, I direct them to observe their own living environment. That makes the material feel more real and ultimately easier to understand. Children also become more enthusiastic and active in their learning process."

Learning that links new concepts to students' daily experiences has been shown to be able to form a deeper understanding in students. Through this approach, students are no longer fixated on memorizing material from books alone, but they are able to build connections between the knowledge they learn and the reality they experience in their surroundings (Derman, 2023; Lynch et al., 2012). In addition, it also encourages the formation of critical thinking patterns, because students actively link learning to their real lives (Cahyanto, 2022). This is reinforced by the following statement from the interview results with the class teacher.

> P3: "...With this learning method, I see that children do not only memorize information from books, but they can really relate new concepts to things they have experienced or seen every day.

> P4: "...For example, when discussing natural resources, they immediately mention their parents' rice fields or the limestone mines in their village. This makes their understanding deeper because learning feels close and real. They also become more enthusiastic because they feel that the lesson is directly related to their lives."

The activity not only helps students understand the concept of natural resources but also raises their awareness of the relationship between natural resources in the surrounding environment. To deepen learning, students work on mini projects to identify the natural resources of their area, including digging up information from parents and

neighbors who work as farmers (Cahyanto, et al., 2024). This activity aims to encourage students to actively build understanding based on real experiences in their environment.

On the other hand, the teacher facilitates activities to build new knowledge about the importance of recognizing natural resources and how to protect them. From this activity, the teacher also conducts formative assessments to see students' development in understanding the material (Cahyanto, 2022). From this entire series of activities, it appears that learning does not stop at mastering information, but also encourages students to think critically, analyze contextually, and relate knowledge to real life. This practice shows that the deep learning approach can be applied operationally at the elementary school level by prioritizing active and meaningful learning experiences. As reinforced by the following teacher's statement.

> P5: "...In applying the deep learning approach to science learning, I do not only focus on the cognitive aspect where it is only oriented towards understanding concepts, but I also try to build an affective dimension through mindful learning.

> P6: "...I do this process by inviting students to reflect on the real impacts of irresponsible natural resource management. I often raise local issues such as illegal logging which can cause landslides or environmental pollution due to household waste and its impact on health and environmental sustainability.

Based on this, it can be seen that through appropriate discussions and assignments, teachers have succeeded in training students to understand concepts and evaluate daily behavior that has an impact on nature while inviting them to think of simple solutions as an effort to encourage students' critical thinking (Clare, 2007; McPhail, 2021).

To increase students' awareness to be involved in the learning process that does not only emphasize the end result, teachers pay attention to the process that students go through. Students appear to be actively involved in learning through activities designed by the teacher. Moreover, teachers create a space for expression that encourages students to build experiences related to environmental conservation. Students are invited to share about activities they have done such as planting trees in their yards, sorting waste, utilizing household waste, or participating in community service to clean gutters with villagers. This activity strengthens the connection between the values they learn in school and everyday life practices, so that learning becomes more contextual and authentic (Grauerholz, 2001). This practice is a concrete form of mindful learning where students not only understand the material but also build awareness of the importance of protecting the environment.

This learning allows students to be fully involved in heart, mind, and action to form social awareness from an early age (Grover et al., 2015; Tsai et al., 2022). In the learning

process, teachers assess this involvement through observations and daily journals that show students' attitudes towards the learning process. Thus, mindful learning truly becomes an important instrument in forming the character of students who care and are responsible for the future of the environment around them, as stated by the following teacher.

P7: "...When students are invited to understand real issues around them, they become much more aware and motivated. I see how students begin to show changes in attitude, for example being more careful in throwing away trash at school.

P8: "...And I hope this can have an impact on their behavior at home. So I can say that the implementation of mindful learning is very important to form students' awareness and responsibility towards the surrounding environment."

In an effort to create a fun learning atmosphere, grade IV teachers also design interesting learning. One strategy used is to combine project-based learning designed to foster creativity and strengthen students' understanding of the subject matter being studied (Bishop & Bishop, 2024; Ertugrul et al., 2024). In practice, students are divided into small heterogeneous groups and then they are given the task of making processed works from the natural resources in the surrounding environment. The teacher provides simple tools and materials needed by students in the project, this activity is carried out through corn processing activities together with the hope of encouraging students to work together and express their ideas creatively and be directly involved in making the product (He & Tao, 2025). After the project is completed, each group presents the results of the product in front of the class which also trains self-confidence. The products that have been presented are then eaten together to create pride in their own work.

Not only that, to keep students' enthusiasm high, teachers also insert educational game activities. One of them is a group quiz using picture cards. This activity is packaged like a quiz game interspersed with enthusiastic applause or cheers. This game can foster accuracy and the ability to link information critically (Bhasin, 2024; Gamba, 2024). From this game, the class becomes lively and dynamic, besides that in a comfortable and pleasant learning atmosphere, students seem more motivated to learn and absorb the material more easily (Miller & Krajcik, 2019). As conveyed by the following student.

P9: "...From this game, the class feels more exciting and not boring. We can learn while playing, so we don't feel tired or sleepy. Especially when there are quizzes and guessing pictures, everyone becomes very enthusiastic."

P10: "...We can also work together with our group mates. We understand the lesson material better because the examples are easy to understand according to everyday life. Learning becomes fun and we become more enthusiastic about participating in the lesson."

Based on the explanation above, it can be concluded that joyful learning has a strategic role in increasing student engagement emotionally and socially. A fun and interactive learning atmosphere creates a sense of comfort in students which in turn encourages their learning motivation (Blom & Severiens, 2008). Through interesting activities such as educational games, group projects, and presentations, students feel happy and encouraged to participate and collaborate. This indirectly forms their positive perception of the learning process as a fun and non-burdensome activity. Thus, deep learning not only increases the effectiveness of learning but also becomes an important foundation in building long-term learning perceptions and interests in students (Ardiansyah & Nugraha, 2025; Juarminson, 2021). Overall, the findings of the application of deep learning can be seen in Table 3 below.

Deep Learning Principles	Characteristics of Learning	Learning Activities
Meaningful Learning	Learning that emphasizes the importance of the relationship between new knowledge and the experiences or knowledge that students already have.	The teacher begins by exploring students' initial knowledge about the natural resources around the school such as rice fields and gardens and the types of natural products available in the area such as rice and corn. Furthermore, students are invited to identify and analyze the use of these natural resources in daily activities through processing corn fields into creative products, to strengthen students' understanding they are given a project to make a report based on the results of information gathering from various sources.
Mindful Learning	Learning that facilitates students' awareness to be fully involved in the learning process by involving themselves mentally and emotionally, and paying full attention to the material being studied.	The teacher conveys the local context regarding natural resources in the surrounding environment, then students are invited to discuss their use by the community, both as staple foods and as processed products. The teacher sparks student awareness through reflective questions "How do we utilize natural resources to produce more diverse products for the community?". Next, students work in groups to design processed product ideas and carry out practices followed by presentations and reflections on their work. Through this process, students are invited to build awareness of their role in maintaining the sustainability and natural wealth of their surroundings.
Joyful Learning	Fun learning that can foster enthusiasm for learning and increase student involvement through interactive, exploratory and collaborative activities to create student learning comfort.	Teachers carry out learning through creative and fun activities by delivering materials interactively with the help of visual media images, short videos, and local maps to attract students' attention. Furthermore, students are invited to work on simple projects to identify types of natural resources around the environment and their utilization. In addition, teachers insert educational games with quizzes to match images of natural products with their processed products. This learning activity is carried out in a fun and relaxed atmosphere. That way, it is hoped that students can feel that learning is a fun activity.

Table 3. Application of Deep Learning in Classroom Learning

Overall, the findings from the implementation of the deep learning approach in grade IV of SDN 2 Ringinanom show the effectiveness of this approach in creating a complete and meaningful learning experience for students. The integration of the principles of meaningful, mindful, and joyful learning has been shown to improve students' understanding of the material and also strengthen their affective and social dimensions (Sun, 2025). Learning is no longer one-way and oriented towards memorization, but encourages students to actively think critically, apply knowledge, and reflect on the material with real life according to the issues around them. This shows that the deep learning approach is able to answer th e needs of today's education which demands more than just the transfer of knowledge but also the development of critical and innovative thinking skills to face the complex and dynamic realities of life (Tsai et al., 2022; Zhang & Ma, 2023).
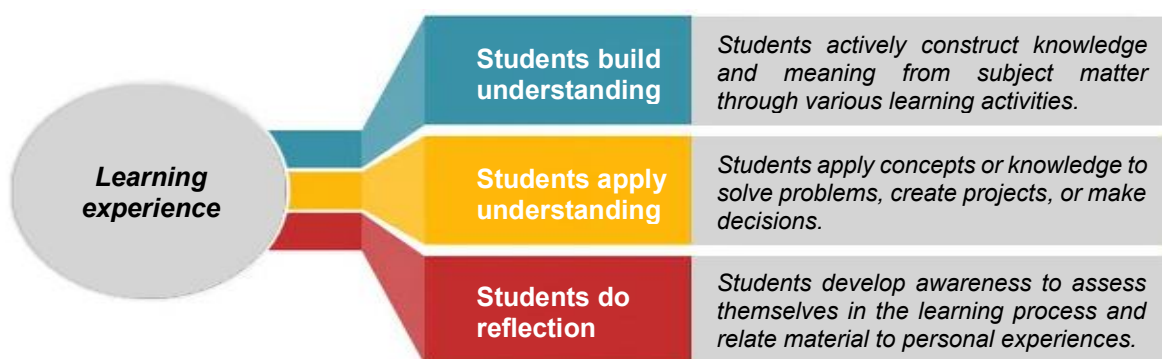

Figure 1. Learning experience in deep learning applications

Based on this explanation, it can be understood that in the application of deep learning, students experience three important stages, starting from understanding, applying, and reflecting. Understanding is the main foundation, where students do not just memorize information but really construct the meaning of the subject matter through the process of critical thinking, discussion, and connections between concepts. This deep understanding is important because it is the basis for students to build lasting and relevant knowledge. In addition, applying places students as active subjects in learning, allowing them to use knowledge to solve real problems, create works, or make meaningful decisions (Sufian et al., 2020).

The urgency of implementing deep learning in the context of learning, especially in elementary schools, also lies in its contribution to fostering 21st-century skills such as problem solving, collaboration, and creativity. These skills are not only important in an academic environment, but are also very relevant to the very dynamic challenges of the future. In the deep learning process, students are encouraged to explore problems,

design solutions, and work together in groups to achieve learning goals. This condition creates an active and meaningful learning experience, so that the transfer of knowledge is not mechanical but transformative. According to Trilling & Fadel (2009), 21st-century skills are built through learning activities that emphasize high-level thinking processes, collaboration, and problem solving that are integrated into deep learning practices.

On the other hand, the reflection process is an important element that strengthens the deep learning process, this learning experience allows students to evaluate their learning process and results in depth. Reflection provides space to realize the strengths, limitations, and developments that have been achieved in the learning process, and also becomes a bridge to continuous learning. By reflecting, it is expected that students will not only grow cognitively but also affectively and metacognitively. Pang et al. (2017) emphasized that reflection is the key to learning, because through reflection students become more self-aware and responsible for their actions. Therefore, the integration of understanding, application, and reflection within the deep learning framework provides a holistic learning experience to form emotionally and socially mature students.

Impact of Implementing Deep Learning Approach

The implementation of the deep learning approach in learning Natural and Social Sciences (IPAS) at SDN 2 Ringinanom Ponorogo has made a substantial contribution to improving the quality of learning. This is reflected in a significant increase in learning outcomes and student participation during the learning process. Qualitatively, this approach has succeeded in shifting the learning paradigm from initially focusing on one-way knowledge transfer, to an interactive process that actively involves students both cognitively, affectively, and psychomotorically. The teacher acts as a facilitator who guides students to build understanding through exploratory and collaborative processes. From an affective perspective, the deep learning approach appears to strengthen students' emotional closeness to the material being studied. When students are invited to discuss real issues around them, they not only understand conceptually but also show empathy, concern, and a sense of responsibility (Tsai et al., 2022).

These values grow naturally through learning based on local contexts and their daily life experiences. Student engagement also increases because they feel the learning is relevant and meaningful, thus creating an intrinsic drive to actively participate (Jarbou et al., 2022; Putri et al., 2024). Socially, project-based learning and group discussions encourage students to interact, work together, and respect each other's opinions. In this process, they learn to build arguments, listen, and respond critically. This is an important

indicator for forming the social competencies needed in the future. On the other hand, the application of the deep learning approach is able to equip students to think more deeply and systematically. They not only remember information, but also understand the reasons and meanings behind it, and are able to apply it in real situations (Rini & Cahyanto, 2020; Wathon, 2024).

Thus, empirically, these findings show that the deep learning approach has real effectiveness in improving the quality of learning at the elementary school level. The increase in student learning outcomes reflected in the formative and summative assessment scores shows that learning is not only successful in transferring knowledge, but also deepening students' understanding of the material. Moreover, this approach also has a significant impact on the aspect of student engagement. The results of class observations and students' daily journal entries show an increase in active participation, enthusiasm, and high interest in learning during the learning process. Students are not only involved cognitively, but also emotionally and socially, which shows that deep learning is able to create learning that touches all dimensions of student development. These findings strengthen the argument that meaningful, reflective, and enjoyable learning has a major contribution in forming a conducive classroom climate and transformative learning (Cahyanto, 2023). Therefore, deep learning is worthy of consideration as the main pedagogical approach in the implementation of the Independent Curriculum.

CONCLUSION

The results of this study confirm that the implementation of the deep learning approach at SDN 2 Ringinanom has not only succeeded in improving the quality of the learning process and outcomes but also made an important contribution to the development of science in elementary education. This approach, which integrates meaningful learning, mindful learning, and joyful learning, has been proven to be able to create a learning experience that is not only focused on academic achievement, but also fosters students' awareness, reflection, and deep emotional involvement. In the context of elementary education, this is very relevant because students are in a developmental phase that requires learning that is not only informative, but also shapes attitudes, values, and character.

Therefore, the deep learning approach contributes to expanding the boundaries of elementary education science, from being oriented towards memorization and achieving values, to an approach that fosters conceptual understanding, critical thinking skills, and

social and emotional skills. In addition to enriching constructivist learning theory, the results of this study also emphasize the urgency of developing contextual, holistic, and transformative learning models as a response to the challenges of the 21st century. Thus, these findings are not only of practical value for application in the classroom, but are also strategic in building a new theoretical framework that is relevant to the dynamics of basic education in the digital era and the ever-evolving global society.

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