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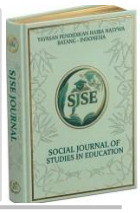

Integration of Deep Learning in IPAS Learning Models Based on Project-Based Learning in Elementary Schools

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Abstract

The paradigm shift in 21st-century education requires the transformation of science, technology, engineering, and mathematics (STEM) learning in elementary schools so that it is no longer merely about memorizing facts, but rather focuses on deep conceptual understanding and mastery of critical thinking skills. This study aims to develop a conceptual model that explains how the integration of Deep Learning pedagogical principles can strengthen the PjBL model in science learning at the elementary school level. The method used is library research with content analysis techniques on scientific articles, proceedings, and research reports from the Google Scholar, Garuda, and DOAJ databases. The analysis was carried out through the stages of categorization, synthesis, and interpretation of the implementation aspects of Deep Learning and PjBL. The research findings show that the integration of Deep Learning in PjBL-IPAS produces optimal synergy that combines conceptual dimensions (depth of material), social dimensions (collaboration), and affective dimensions (emotion management). The conclusion of this study confirms that the integration of Deep Learning in PjBL-IPAS is an effective synthesis that is in line with the spirit of the Merdeka Curriculum. As a recommendation, further empirical research in the field is needed to test the effectiveness of this conceptual model and to develop practical learning tools for teachers in the classroom.

Kata Kunci:
deep learning, project based learning, ipas, sekolah dasar

Abstrak

Pergeseran paradigma pendidikan abad ke-21 menuntut transformasi pembelajaran IPAS di Sekolah Dasar agar tidak lagi sekadar menghafal fakta, melainkan fokus pada pemahaman konseptual yang mendalam dan penguasaan keterampilan berpikir kritis. Penelitian ini bertujuan untuk menyusun model konseptual yang menjelaskan bagaimana integrasi prinsip pedagogis Deep Learning dapat memperkuat model PjBL dalam pembelajaran IPAS di tingkat Sekolah Dasar. Metode yang digunakan adalah studi pustaka (Library Research) dengan teknik analisis konten terhadap artikel ilmiah, prosiding, dan laporan penelitian dari basis data Google Scholar, Garuda, dan DOAJ. Analisis dilakukan melalui tahapan kategorisasi, sintesis, dan interpretasi pada aspek implementasi Deep Learning dan PjBL. Temuan penelitian menunjukkan bahwa integrasi

Deep Learning dalam PjBL-IPAS menghasilkan sinergi optimal yang menggabungkan dimensi konseptual (kedalaman materi), dimensi sosial (kolaborasi), dan dimensi afektif (pengelolaan emosi). Simpulan studi ini menegaskan bahwa integrasi Deep Learning dalam PjBL-IPAS merupakan sintesis efektif yang selaras dengan semangat Kurikulum Merdeka. Sebagai rekomendasi, diperlukan penelitian empiris lebih lanjut di lapangan untuk menguji efektivitas model konseptual ini serta pengembangan perangkat pembelajaran yang praktis bagi guru di kelas.

INTRODUCTION

Natural and Social Sciences (IPAS) subjects at the elementary school level play an important role in fostering scientific literacy, higher-order thinking skills, and social awareness in students from an early age (Mawaddah et al., 2025). The paradigm shift in 21st-century education, which emphasizes the mastery of critical thinking, creativity, collaboration, and contextual learning skills, requires a learning model that is capable of fostering a deep conceptual understanding, rather than merely mastery of factual knowledge (Dewindri, Sa'dah, et al., 2025). A number of recent studies show that learning approaches that emphasize meaningful, mindful, and joyful learning, often referred to in the pedagogical realm as deep learning, have been proven to increase student engagement and thinking skills when designed with the right instructional approach (Royani et al., 2024).

Project-Based Learning (PjBL) places learners as active subjects in solving real challenges that demand critical thinking, problem solving, and collaboration skills to produce meaningful products (Ilham & Amal, 2023). More than just an instructional method, this model builds a learning ecosystem that facilitates deep understanding through direct involvement. However, current literature is still dominated by a quantitative results orientation, where children's success is often measured only by improved test scores or formal academic achievement (Widyastuti & Widiyono, 2024). This leaves a large gap in our understanding of the subjective experience and social processes experienced by students (Ilham & Amal, 2023). Therefore, further exploration is needed to uncover the personal narratives and meanings behind the learning process, in order to complement the statistical perspective that has dominated the PjBL discourse.

The Merdeka Curriculum, with its principles of joyful, mindful, and meaningful learning, forms the core of an adaptive approach to be implemented in elementary schools (Kemendikdasmen, 2025). Although qualitative research highlighting the subjective experiences of students in the deep learning process is still limited, these principles are pedagogically recognized as the foundation of Deep Learning (Hatima & Saputra, 2025). The application of Deep Learning requires a shift in focus from merely mastering factual information to students' ability to connect concepts, reflect on experiences, and apply their knowledge in real-life contexts (Budhiarti et al., 2025). Therefore, a learning model is needed that not only provides content but also facilitates the process of authentic meaning construction.

Theoretically, the Project-Based Learning (PjBL) model has a very strong

alignment with the principles of Deep Learning because both emphasize exploratory activities and the creation of real products as a means of building knowledge (Anisa et al., 2025; Kemendikdasmen, 2025). Many studies have proven the positive impact of PjBL in improving conceptual understanding, strengthening teamwork, and even inspiring genuine motivation to learn from within students (Ilham & Amal, 2023; Novita Barokah & Umi Mahmudah, 2025; Nugraha et al., 2022). However, behind the apparent success, there is still very little research documenting the micro-processes that occur in the classroom. We still rarely see how warm interactions between students take place, how they negotiate meaning when faced with differences of opinion, or how shared reflection practices become a bridge to deeper understanding. This gap in the documentation of human dynamics needs to be filled immediately so that we can truly understand how Deep Learning works in practice.

Previous studies have also highlighted various systemic barriers to educational innovation, ranging from teachers' limited pedagogical competencies and inadequate school infrastructure to increasingly sharp inequalities in access to digital technology. A number of literature studies have shown that the principles of deep learning can still flourish through the utilization of local potential and cultural context without having to rely entirely on sophisticated digital devices. Efforts to explicitly combine the local environmental context, the PjBL model, and learning experiences that touch the depths of students' hearts are still rarely studied systematically (Isnayanti et al., 2025). The integration of local wisdom is not merely an addition to the material, but rather an anchor that makes learning feel closer and more relevant to the real lives of students, so that the process of knowledge construction becomes more honest and deeply rooted in their reality.

This literature review reveals several gaps that need attention in this study. First, most studies focus on cognitive and affective learning outcomes, while the aspects of personal experience and the meaning of learning as perceived by students have not been widely studied. Second, analysis of social processes in classroom dynamics is still minimal, even though interaction, argumentation, and role sharing are important mechanisms for deep learning in PjBL. Third, the integration of local contexts as a source of learning meaning has been under-explored, although some studies have touched on the potential of local wisdom as contextual teaching material. Fourth, the dominance of quantitative approaches and R&D designs limits theoretical contributions, as few studies have developed conceptual models to explain how and why deep learning occurs in PjBL practices in IPAS. Thus, although the current literature shows that the integration of deep learning and PjBL has great potential, a more in-depth analysis of the underlying dimensions of experience, meaning, and social processes is still needed.

Based on these gaps, this study aims to develop a conceptual map and theoretical synthesis that explains how the integration of deep learning pedagogical principles into the Project Based Learning model can create meaningful learning experiences and support social processes that strengthen conceptual understanding in science education in elementary schools. This study seeks to enrich theoretical understanding while providing practical direction for innovation in basic education. A systematic and critical literature review approach is expected to bring together diverse scattered evidence into a comprehensive conceptual model that can serve as a foundation for future research and educational practice.

METHODS

This study uses a qualitative approach with library research. The main data in this study are sourced from scientific journal articles and national proceedings. The focus of the study covers three main aspects, namely the implementation of deep learning in elementary school education, the application of the Project Based Learning model in IPAS subjects, and the integration of deep learning in the PjBL-based IPAS learning model in elementary schools. The research location in this study uses digital space, allowing researchers to access a wider range of literature without being limited by location. This study does not collect new field data but interprets and conceptualizes existing evidence to formulate a more comprehensive theoretical framework regarding the deep learning process. The literature search was conducted through the Google Scholar, Garuda, and DOAJ databases using a combination of keywords: deep learning, Project Based Learning, IPAS, and Elementary School.

The data collection techniques used in this study consisted of two main methods, namely literature study and content analysis. The literature study was conducted by collecting various sources of literature related to the research topic. After the data was collected, the researcher conducted content analysis to examine the existing literature in more depth. The final stage was interpretation, in which the researcher interpreted the results of the data synthesis to formulate conclusions regarding the integration of deep learning in PjBL-based IPAS learning in elementary schools. Data analysis in this study used three stages, namely categorization, synthesis, and interpretation. In the categorization stage, the data was classified based on topics related to deep learning, IPAS learning, PjBL, and elementary schools. In the synthesis stage, the researcher combined information from various literature to obtain a comprehensive understanding. In the final stage, interpretation, the researcher interpreted the results of data synthesis to formulate conclusions regarding the integration of deep learning in PjBL-based IPAS learning models in elementary schools.

RESULT AND DISCUSSION

Implementation of Deep Learning in Elementary School Education

The implementation of deep learning in elementary education is a systematic effort to shift the focus of learning from merely mastering factual information to a deeper conceptual understanding. This approach emphasizes the integration of the principles of meaningful, mindful, and joyful learning as instruments to increase the cognitive and emotional engagement of students. In practice, deep learning facilitates students to observe, critically analyze, and connect new knowledge with real experiences they encounter in their daily lives. Various studies show that when these principles are applied, the learning process in the classroom becomes more dynamic and centered on the intellectual activities of independent students. This provides a strong foundation for the development of science literacy and social awareness at the primary education level through more substantive and integrated material, rather than just a superficial coverage of the curriculum. The following is a table of several previous studies discussing deep learning in primary school education:

Table 1. Implementation of Deep Learning in Primary School Education

Source	Focus	Findings	Important Information
(Guandensi	IPAS	teaching module	The implementation of joyful, mindful,

a et al., 2025)	integrated with deep learning principles	meaningful learning principles in teaching modules improves thinking skills without dependence on technology.
(Royani et al., 2024)	Deep learning model in elementary school social studies learning	Deep learning encourages students to actively discuss, think critically, and understand social studies concepts in depth through a constructivist approach.
(Dewindri, Sa'dah, et al., 2025)	Deep learning strategies to foster curiosity in elementary school students	Deep learning is applied through inquiry-based and problem-based learning to build students' curiosity and motivation to learn.
(Puspita et al., 2025)	Deep learning approach in elementary school science learning	The application of meaningful, mindful, joyful learning fosters student engagement and higher-order thinking skills in science learning.

Research conducted by Guadensia et al. (2025) confirms that the application of deep learning principles does not depend entirely on the availability of complex digital technology support. Their study focused on the effectiveness of using IPAS teaching modules designed by integrating the principles of meaningful, conscious, and enjoyable learning. Through the implementation of the Project-Based Learning model and the optimization of environmental exploration activities, this study proved a significant increase in students' critical thinking skills. These findings have important implications for the development of learning models in elementary schools with limited technological facilities, especially in certain regions. This shows that the essence of deep learning lies in the quality of pedagogical design and the ability of teachers to utilize the environmental context as an effective learning resource, so that knowledge construction can still run optimally without always having to rely on the latest digital infrastructure.

Royani et al. (2024) through a case study at SD Global Garuda Nusantara showed that the deep learning model proved effective in deepening students' understanding of conceptual social studies material. This approach consistently encourages interaction through discussion, critical reflection, and active participation during the instructional process. Although it has yielded positive results in terms of student understanding, this study also identified operational challenges, such as uneven teacher pedagogical competence and limited learning support facilities. These findings indicate that the transition to deep learning practices requires systemic support, including structured professional training programs for educators. Strengthening teacher capacity is an absolute requirement for the sustainable implementation of deep learning principles, so that teachers have the adequate skills to design complex learning scenarios that are responsive to the intellectual development needs of elementary school students.

Dewindri et al. (2025) through their literature review explain that deep learning-based learning strategies can significantly foster curiosity and intrinsic motivation in students. The implementation of inquiry-based learning and problem-based learning methods in this framework has been proven to make students more independent and have strong reflective abilities in the process of knowledge construction. These findings support the relevance of integrating deep learning into the Merdeka Curriculum structure, which emphasizes the development of critical curiosity and higher order thinking skills (HOTS) from an early age. By providing opportunities for students to explore issues in depth, the

learning process shifts from merely receiving information to an active search for meaning. This not only has an impact on academic achievement but also forms the foundation of a learner's character who is able to think systematically and analytically in facing various real-world problems they encounter in their surroundings.

The research by Puspita et al. (2025) at SDN 58 Mojo Sragen reinforces the evidence that the deep learning approach in science subjects contributes to improving students' conceptual understanding and developing their scientific attitudes. By applying the principles of mindful, meaningful, and joyful learning, the science learning process becomes more contextual and relevant to students' daily lives. In this context, the role of teachers is transformed into that of facilitators who guide students to explore systematically, reflect on their learning experiences, and relate scientific theories to factual phenomena. The success of this implementation shows that a positive and meaningful learning atmosphere makes it easier for students to absorb abstract scientific concepts and turn them into functional knowledge. The integration of good classroom management and deep learning strategies is the key to producing students with high scientific literacy, where they are able to apply scientific reasoning in understanding the dynamics of nature and the social environment more comprehensively.

The results of the study in Table 1 show that the implementation of deep learning in the context of elementary school learning is carried out through various approaches that are oriented towards student activity, the creation of meaningful learning experiences, and the strengthening of higher-order thinking skills. Each study implemented the principles of deep learning in different ways, ranging from the use of interactive digital media, the development of contextual teaching modules, to the application of project-based and inquiry-based strategies. In general, these applications have been proven to increase learning motivation, foster curiosity, and deepen students' conceptual understanding, especially in IPAS and science subjects. Based on the key findings from Table 1 regarding the implementation of Deep Learning in the context of primary education, particularly as it relates to IPAS learning. In general, the results of the study show that the application of Deep Learning principles in primary schools is highly oriented towards strengthening student activity, personalizing learning experiences, and developing higher-order thinking skills (HOTS), both through technological support and purely pedagogical approaches.

Several studies highlight that the principles of Deep Learning do not always depend on sophisticated artificial intelligence infrastructure. Puspita et al. (2025) and Guadensia et al. (2025) both emphasize the pedagogical implementation of Deep Learning through three main pillars: meaningful, mindful, and joyful learning. These principles, which are integrated into the IPAS and IPA teaching modules, effectively encourage students' thinking skills without relying on technology, as well as fostering deep engagement and higher-order thinking. This is in line with the core of PjBL, which also emphasizes meaningful and contextual learning (Ayuningrum et al., 2024). This finding is particularly relevant to the context of elementary schools in Indonesia, which may have limited resources, showing that Deep Learning can be implemented as a pedagogical framework that emphasizes depth of understanding over breadth of material coverage.

Although overall research results show a positive impact, the success of implementing Deep Learning in the PjBL model in IPAS subjects is highly dependent on the readiness of human resources and educational infrastructure. Royani et al. (2024) argue that the low readiness of teachers and limited supporting facilities remain the main

challenges that hinder the effectiveness of the learning process in the field. This finding is in line with Martati's (2022)study, which emphasizes that the majority of teachers have not accurately mastered the concept of project-based learning, thus requiring strategic interventions in the form of workshops or intensive training. Therefore, in order for the integration of Deep Learning to run optimally, educational institutions are required to organize comprehensive professional training. The training must focus on strengthening the capacity of teachers to be able to act as skilled facilitators in guiding students to explore, reflect, and relate IPAS material to real life. In addition, mastery of Deep Learning-based digital tools is an essential additional competency for teachers to create a more contextual and adaptive learning experience in line with the times Royani et al. (2024).

The Application of Project-Based Learning (PjBL) in Science Education

The implementation of Project-Based Learning (PjBL) in Natural and Social Sciences (IPAS) subjects in elementary schools is a pedagogical strategy designed to bridge academic theory with real-world practice. This model allows students to explore natural phenomena and social dynamics through a series of independent investigations that culminate in the creation of concrete products. Through systematic project stages, PjBL not only functions as a method of delivering material, but also as an instrument for building character, independence, and logical thinking skills in students. In the context of IPAS, the use of projects provides opportunities for students to understand cause-and-effect relationships and the relevance of science in their daily lives. Thus, PjBL is a strategic solution for creating a more interactive and meaningful learning atmosphere, while equipping students with the essential competencies needed to face the complex challenges of the future. The following is research relevant to the application of PjBL in IPAS learning:

Table 2. Application of Project Based Learning (PjBL) in IPAS Learning

Source	Focus Findings	Important Information
(Febiyanti et al., 2024)	Analysis of PjBL Implementation on the Learning Activity of Grade IV Elementary School Students in Science Learning	The PjBL model succeeded in making Grade IV elementary school students more active in science lessons because students felt more motivated to participate in learning.
(Alwanda, 2025)	Systematic Review of PjBL Implementation to Improve Creative Thinking Skills of Elementary School Students in Science Learning	The results of the systematic review show that PjBL is very effective (50%) in developing students' creativity, courage to express opinions, and ability to design solutions in the context of science.
(Martati, 2022)	Description of Muhammadiyah Elementary/MI Teachers' Knowledge of Project-Based Learning (PjBL)	Although recommended in the Merdeka Curriculum, the implementation of PjBL requires workshops because many elementary/MI teachers still do not fully understand the concept.
(Nugraha et al., 2022)	Improving Creativity and Science Learning Outcomes in 5th Grade	The application of the PjBL model has been proven effective in increasing the learning creativity of 5th grade elementary school

	Elementary School Students through PjBL	students in science subjects from the "not creative" category to "creative".
(Ayuningrum et al., 2024)	Application of PjBL to Problem-Solving Skills in IPAS Learning (Respiratory System Teaching Aids Project)	The implementation of the PjBL model through a simple teaching aids project has been proven to provide significant benefits in developing students' problem-solving and collaboration skills in IPAS learning.

Febiyanti et al. (2024) conducted a qualitative study at SD Negeri Babakan Madang 05, analyzing how the implementation of PjBL affected the activity of fourth-grade students in science lessons. The conclusion drawn is that this project-based learning model has proven to be effective in boosting activity, mainly because it has succeeded in creating a higher level of motivation and interest in the overall teaching and learning process. Furthermore, Alwanda (2025) conducted a systematic review of 22 articles to explore the effectiveness of PjBL in improving the creative thinking skills of elementary school students in science lessons. The results of the study show that PjBL is believed to be very potential, rated as effective to very effective, not only in advancing creativity, but also in shaping students' courage to voice their opinions and their ability to design innovative solutions to problems.

Regarding the readiness of educators, Martati (2022) conducted descriptive research on the level of understanding of Muhammadiyah elementary school/MI teachers in Surabaya regarding the PjBL concept within the framework of the Merdeka Curriculum. Although this model is formally recommended as the main means of achieving competency mastery through the production of work, the data shows that most teachers still experience difficulties in accurately understanding the basic principles and implementation procedures. This condition indicates a gap between curriculum policy and practical capacity in the field, requiring concrete steps to address the problem. There is an urgent need for workshops and ongoing professional training to strengthen teachers' mastery of the material and methodological skills. Without proper conceptual understanding on the part of educators, the great potential of the PjBL model in transforming IPAS learning will not be optimally realized, given that teachers are the main navigators in this project-based learning scenario.

The positive effects of PjBL are also clearly recorded in Classroom Action Research (PTK) by (Nugraha et al., 2022), which focuses on improving the creativity and science learning outcomes of fifth-grade elementary school students. The data showed a significant increase in learning creativity, as evidenced by an increase in the pre-cycle percentage of 64.34% (non-creative category) to 81.99% (creative category) after the implementation of PjBL in the second cycle. This increase proves the efficacy of PjBL as a model capable of stimulating students' divergent thinking potential through structured exploration activities. In line with these findings, Ayuningrum et al. (2024) examined the application of PjBL through a project to create respiratory organ teaching aids in the context of IPAS learning. This qualitative narrative study emphasizes that the implementation of PjBL provides holistic benefits, including the development of problem-solving skills, the strengthening of communication between students, and the ability to collaborate in teams. These results confirm that PjBL is a multifaceted model capable of simultaneously and integrally addressing various dimensions of student development.

The synthesis of these various studies consistently shows that PjBL has a strong transformative power on the instructional process at the elementary level. This model is not

only effective in increasing student engagement by creating high motivation to learn, but also contributes directly to the improvement of higher-order cognitive skills and the formation of scientific character (Febiyanti et al., 2024). PjBL facilitates students to learn through direct experience, which in turn strengthens memory retention of the IPAS concepts learned. Through the stages of investigation and reflection, students are trained to be resilient in facing technical and conceptual obstacles during project completion. Overall, the integration of PjBL in IPAS learning is an innovative step that supports the creation of critical, creative, and independent learners. This study emphasizes that the success of PjBL lies in its ability to integrate the dimensions of knowledge, skills, and attitudes into a complete, contextual learning process that focuses on the needs of students.

This finding is very clear in the context of creativity and problem-solving skills. Alwanda (2025) concluded that PjBL is very effective (achieving 50%) in honing creativity and building students' courage to express their opinions. This data is reinforced by Classroom Action Research (CAR) by Nugraha et al. (2022), which shows a significant increase in the creativity of fifth-grade elementary school students from the “uncreative” category to the “creative” category after the implementation of PjBL. Furthermore, Ayuningrum et al. (2024) showed that through real projects (making respiratory system teaching aids), PjBL significantly hones problem-solving and collaboration skills. These skills are essential in science subjects that require integrated and contextual understanding of concepts. Thus, PjBL has been proven to shift the focus of learning from mere knowledge transfer to the formation of applied competencies through direct experience.

The PjBL model, especially through contextual IPAS projects (e.g., the respiratory system project by Ayuningrum et al. (2024), is highly relevant to the philosophy of the Merdeka Curriculum, which integrates science and social studies into IPAS. Multidisciplinary projects enable students to apply scientific knowledge (Science) while understanding its impact on the environment and society (Social). The nature of the project challenges students to design innovative solutions (Alwanda, 2025). This meets the demands of the Merdeka Curriculum's Deep Learning to develop the dimensions of independent and critical thinking graduates (Kemendikdasmen, 2025). Thus, PjBL is an ideal pedagogical mechanism for realizing the main objectives of IPAS learning in elementary schools.

Integration of Deep Learning in Project-Based Learning Based on Science

The integration of deep learning in project-based science learning in elementary schools represents a new direction in the development of pedagogy that is oriented towards reflective, collaborative, and meaningful learning experiences. Based on the synthesis of various studies, the application of deep learning principles in science and social studies subjects is realized through activities that guide students to understand concepts deeply, rather than merely memorizing scientific and social facts. As described in (Dewindri, Sa’diah, et al., 2025). This approach emphasizes the active involvement of students in exploring, observing, and reflecting on natural and social phenomena they encounter in their daily lives. Through this process, students learn to relate theory to empirical experience, giving rise to contextual and meaningful conceptual understanding.

The analysis in the study by Ginting et al. (2025) shows that the application of deep learning in the context of IPAS can be facilitated through a learning design that combines elements of mindful learning and joyful learning. This approach trains students to think

critically and creatively in responding to the problems they encounter while fostering reflective awareness of the social value of the results of their activities. For example, when students carry out waste management or water conservation projects, they not only understand the scientific principles behind them, but also learn about social responsibility and ethics. In this way, deep learning not only enriches the cognitive realm, but also fosters empathy and social awareness.

Based on the findings of research by Ilham & Amal (2023) and Royani et al. (2024), the Project Based Learning (PjBL) model has proven to be a strategic vehicle for realizing the principles of deep learning in IPAS learning. Through PjBL, students are directly involved in collaborative projects that require them to gather information, discuss, interpret findings, and produce concrete products such as mini reports or simple models. Such activities foster a deep meaning-making process because students gain authentic learning experiences through social interaction. Research by Astawan and Sukma (2024) in (Ilham & Amal, 2023) confirms that group work in IPAS projects involves intense communication and a process of idea negotiation between students, which is the basis for social knowledge construction as described in Vygotsky's constructivist theory. In line with this, the findings in Guadensia et al. (2025) study show that the success of deep learning integration greatly depends on the role of teachers as facilitators of reflection and guides for exploration. Teachers play a role not only as conveyors of information, but also as directors of interaction and guides for student reflection. When teachers encourage students to interpret social phenomena or scientific experiments from various perspectives, they help students achieve a deeper understanding and strengthen their critical and collaborative thinking skills Guadensia et al. (2025). This approach is in line with the principle of joyful learning, where learning activities become enjoyable because they are relevant to students' life experiences and provide space for self-expression.

Overall, a review of various sources shows that the integration of deep learning in PjBL-IPAS in elementary schools takes place in three main dimensions. First, the conceptual dimension, which emphasizes the integration of natural and social sciences and encourages interdisciplinary understanding. Second, the social dimension, which fosters collaboration, communication, and reflection as a means of building shared meaning. Third, the affective dimension, which fosters curiosity, responsibility, and self-awareness in the context of students' real lives. The synergy of these three dimensions makes IPAS not only a medium for knowledge transfer, but also a vehicle for character building, social empathy, and deep and sustainable thinking skills (Desiyani et al., 2024). Thus, the integration of deep learning in the PjBL-IPAS model can be understood as a synthesis of cognitive, social, and emotional approaches that are in line with the spirit of the Merdeka Curriculum. The focus of learning is no longer limited to the final results of the project, but rather on the process of students constructing meaning, managing emotions, and interacting reflectively during learning activities. These findings confirm the relevance of deep learning as a pedagogical framework that supports the formation of graduate profile dimensions, namely critical reasoning, collaboration, and creativity.

CONCLUSION

The study concludes that the integration of Deep Learning principles into Project-Based Learning (PjBL) provides a theoretically coherent and pedagogically relevant model

for IPAS learning in elementary schools. The synthesis of the reviewed literature demonstrates that the integration operates through three interconnected dimensions: the conceptual dimension, which promotes deeper interdisciplinary understanding of natural and social sciences; the social dimension, which strengthens collaboration, communication, negotiation of meaning, and reflective interaction; and the affective dimension, which develops curiosity, responsibility, emotional awareness, and meaningful engagement. PjBL provides an appropriate pedagogical structure for realizing Deep Learning because students actively investigate contextual problems, connect scientific concepts with real-life experiences, collaborate in producing tangible outcomes, and engage in reflection throughout the learning process. Accordingly, Deep Learning-integrated PjBL can move IPAS instruction beyond factual knowledge transmission toward a more meaningful, contextual, reflective, and student-centered learning experience that supports the development of critical reasoning, creativity, collaboration, and sustainable scientific and social awareness.

This study is limited by its library research design and reliance on secondary literature, as it does not provide new empirical evidence regarding the implementation or effectiveness of the proposed Deep Learning-integrated PjBL model in actual elementary-school classrooms. The reviewed literature also indicates that successful implementation is influenced by contextual factors, particularly teachers' pedagogical competence, understanding of PjBL, and the availability of learning facilities and technological resources, which may produce different outcomes across educational settings. Therefore, future research should empirically test the proposed integration through experimental, quasi-experimental, mixed-methods, or classroom-based studies involving diverse elementary-school contexts and grade levels. Further studies are also recommended to develop and validate practical lesson plans, teaching modules, assessment instruments, and teacher training programs that operationalize the conceptual integration of Deep Learning and PjBL in IPAS. Such research would strengthen the empirical foundation of the model and provide more precise evidence regarding its effects on students' conceptual understanding, higher-order thinking, collaboration, creativity, emotional engagement, and meaningful learning experiences.

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