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Deep Learning Approach in Improving Critical Thinking Skills of Elementary School Students

Muhammad Aidil Sudarmono[1], Hasan[2*], Halima[3]

[1] Universitas Muslim Makassar, Indonesia.
[2] UPT SPF SDN Sumanna Makassar, Indonesia.
[3] SMAN 1 Mamuju, Indonesia.

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Corresponding Author:
Hasan
hasangalesong@gmail.com

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Abstract: A deep learning approach in education that creates deep, meaningful, and exhilarating learning experiences, as well as developing students' critical thinking skills. The implementation of this approach has great challenges, especially in terms of teacher competence, curriculum, and supporting facilities. The main objective of this learning is to equip students with critical thinking skills that will not only be useful in school, but also in their daily lives. The research method used is a literature study, which aims to review and analyze various relevant previous research. Data were obtained through searching, identification, and selection of literature indexed in Scholler, and Scopus. Relevant literature was selected based on topic relevance and publication quality, with data analysis using qualitative techniques based on content analysis, including categorization, synthesis of findings, and narrative analysis. The results of the study show that the epistemological gap in teacher competence is the main obstacle in implementing deep learning effectively. Teachers who lack reflective understanding and critical literacy can hinder the goal of deep learning. In addition, a curriculum that does not support active learning based on 21st century skills is also a challenge. Project-based, collaborative, and problem-based learning can improve students' critical thinking skills, but it requires adjustments in the education system. Based on these findings, strategic measures such as improved teacher training, flexible curriculum changes, and the provision of adequate support facilities are essential to optimize the application of deep learning in education. With the right application, deep learning can produce students who are more critical, creative, and ready to face global challenges.

Keywords: Approach; Critical thinking; Deep learning

Introduction

Learning with a deep learning approach focuses on creating meaningful, joyful, and immersive learning experiences for students (Saksono et al., 2024). In the context of elementary school, the main goal is to facilitate the optimal development of students' critical thinking skills (Arkhangelsky et al., 2021). Ideally, the learning process in elementary school should provide space for students to develop critical thinking skills that are not only useful in academia, but also in everyday life.

Critical thinking includes the ability to objectively analyze, evaluate, and assess information, as well as make rational decisions (Juhriah et al., 2024). In ideal learning, students are not only taught to memorize information, but are also invited to understand concepts in depth, question existing assumptions, and develop broader thinking. According to constructivism theory (Piaget, 1952; Vygotsky, 1978), knowledge is built

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through active learning experiences where students construct their own understanding through social interaction and reflection.

The deep learning approach offers an opportunity to change the paradigm of education from simply receiving information to an active process that engages students in problem-solving, concept exploration, and reflection on learning (An et al., 2022). This learning involves open-ended questions that encourage students to think deeply, as well as creating an encouraging classroom climate that invites active student participation. This is in line with humanistic learning theory (Maslow, 2017; Rogers, 1969), which emphasizes the importance of a learning climate that supports curiosity, self-actualization, and active participation of students in the learning process.

Critical thinking is a much-needed skill in the 21st century (S. S. Salmia, 2023). However, in reality, many students around the world struggle in developing critical thinking skills. A 2018 study revealed that only 50% of students in developed countries can demonstrate adequate critical thinking skills, and this percentage is lower in developing countries (OECD, 2019).

This phenomenon reflects the gap in the quality of education that can develop critical thinking skills. Most education systems still place more emphasis on learning based on memorization and repetition of information, which tends to leave little room for students to practice critical thinking (Hayward, 2022). One concrete example of this problem is in math and science learning, where many students simply follow procedures without understanding the basics of concepts or being able to apply them in more complex situations (Moma, 2017; Yuliati et al., 2018). Cognitive learning theory (Bruner., 1997; Nuriana et al., 2023) emphasizes the importance of meaningful learning, where new information is connected to students' existing knowledge so that they are able to understand concepts and apply them flexibly.

Many countries are aware of the importance of critical thinking in the world of education. According to UNESCO, critical thinking is one of the key skills that must be taught in schools to prepare students for the challenges of the 21st century (S. Salmia et al., 2023). Various global education studies and policies show that a more active learning-based approach, which integrates problem-solving and reflection, is essential for developing students' critical thinking skills. Although awareness of the importance of critical thinking is increasing, the same problems are often encountered in many education systems. Students are often not trained to think critically because the learning process does not arouse their curiosity and does not provide them with opportunities to think independently.

At the elementary school level, critical thinking problems often arise because teaching is oriented towards memorization, not on understanding concepts (Hidayat, 2018). Observations conducted in some schools show that many teachers still rely on lecture methods that focus on providing information rather than developing critical thinking skills. In this case, students are more likely to follow the teacher's instructions without questioning or criticizing the information provided.

In addition, observations also show that students often find it difficult to make decisions or provide arguments supported by evidence. For example, in Indonesian lessons, students can write stories fluently, but struggle to give a compelling reason why they chose a particular theme or language style. This shows a lack of opportunities for students to think deeply and reflectively. Social learning theory (Bandura, 1977) is also relevant here, because students learn through observation and modeling; if teachers do not consistently model critical thinking, students will have difficulty developing these skills.

Data from some schools also show that learning that does not actively engage students, such as group discussions or problem-based projects, can inhibit their critical thinking abilities. A study conducted by the Southeast Asia Ministers of Education Organization found that 70% of students who follow traditional learning methods are more passive and have difficulty developing critical thinking skills (SEAEO).

Based on these problems, various solutions have been implemented in several schools to improve students' critical thinking skills. Approaches such as project-based learning, collaborative learning, and inquiry-based learning have been shown to be effective in encouraging students to think more deeply and critically (Rediani, 2017).

One of the solutions that is often applied is problem-based learning, which involves students in real problem-solving (Erawanto et al., 2016). In this model, students are given a problem that they must solve by analyzing information, identifying solutions, and collaborating with their peers. Research shows that PBL can improve students' critical thinking skills because they have to think systematically, evaluate various solutions, and make decisions based on the data they collect (Paratiwi et al., 2023).

In addition, approaches that involve group discussions and self-reflection are also effective in improving critical thinking skills. In some studies, it has been found that students who engage in discussions and debates on a topic tend to be better able to develop strong arguments and consider different points of view.

Among the various approaches that exist, the deep learning approach is the most effective in developing students' critical thinking skills (Aziz et al., 2022). Deep learning includes understanding more than just

memorizing information, but involves the process of internalizing knowledge, applying concepts in different contexts, and reflecting on the learning that has been done.

The constructivist theories put forward by Piaget and Vygotsky support this approach to deep learning, as they emphasize the importance of active learning experiences, in which students build their own knowledge through interaction with their environment and peers (Piaget, 1952; Vygotsky, 1978). Research conducted by Hattie (2009), it also shows that more in-depth and reflection-based learning has a significant influence on improving student achievement, including in terms of critical thinking skills.

A study conducted by Paratiwi et al. (2023) revealing that deep learning can improve students' critical thinking skills by encouraging them to interact more intensely with the learning material, as well as forming a more robust and flexible understanding.

While deep learning approaches have proven to be effective, there are some limitations to be aware of. One of them is the readiness of teachers and school facilities in implementing this learning. The deep learning approach requires changes in teacher teaching and training methods, which may require considerable time and resources (Rahma et al., 2022). In addition, not all students have the same ability to adapt to this method. Some students may find it distressed by a more demanding approach of active engagement, especially if they are not yet accustomed to a more independent and reflective way of learning. Therefore, it is important to provide additional support for students in need.

By applying the deep learning approach in elementary schools, it is hoped that it can create a more critical, creative, and independent generation. The main goal of this learning is to equip students with critical thinking skills that will not only be useful in school, but also in their daily lives. It is hoped that through meaningful, exhilarating, and in-depth learning, students will become more active in the learning process, able to evaluate information objectively, and able to make informed decisions based on careful analysis. This learning also aims to create a fun learning atmosphere, so that students can develop greater interest and curiosity towards various areas of knowledge.

Critical thinking skills are one of the essential competencies of the 21st century that must be developed starting in elementary school. However, various studies show that students' critical thinking skills in many countries, including developing ones, remain low; only around 50% of students in developed countries demonstrate adequate critical thinking skills (OECD, 2019). These low levels of critical thinking are caused by a learning paradigm that is still oriented towards memorization and lectures, which provide little space for students to explore concepts, ask questions, and develop reflective thinking (Hidayat, 2018). The deep learning approach is considered a potential solution because it emphasizes active student engagement through problem-solving, concept exploration, and reflection (An et al., 2022; Aziz et al., 2022).

Previous studies have shown that this approach is effective in improving critical thinking skills at the secondary and tertiary levels (Paratiwi et al., 2023), but its implementation in elementary schools remains limited. Some of the challenges faced include teacher preparedness, availability of supporting facilities, and student adaptation to learning that requires active engagement. Therefore, this research is crucial to explore the effectiveness of implementing in-depth learning in elementary schools to develop critical thinking skills from an early age.

Method

This study uses a literature study approach that aims to review and analyze various previous studies that are relevant to the topic discussed, namely the application of the deep learning approach in improving the critical thinking skills of elementary school students. Literature studies allow researchers to understand previous findings, delve into existing theoretical frameworks, and explore problems that may not have been answered by previous research (S. S. Salmia, 2023).

In literature study research, data collection techniques are carried out through searching, identification, and selection of relevant literature. The data collection process is carried out in the following way:

a) Literature search: Researchers will search for articles, journals, books, and other scientific publications relevant to the research topic. The literature sources used include Sinta 1 and Sinta 2 indexed journals, as well as journals indexed in Scopus. Literature searches are carried out through academic databases such as Google Scholar, Sinta, Scopus, JSTOR, and ProQuest.
b) Literature source selection: Articles used in literature studies must meet certain criteria, including relevance to the research topic, publication quality, and year of publication that includes current research. Articles indexed in the Sinta 1 and Sinta 2 journals and Scopus are considered to be of good quality and can make a significant contribution to this research.
c) Preparation of literature categories: Once the literature is collected, the researcher will classify the literature based on the themes or variables

discussed, such as deep learning techniques, and critical thinking skills.

The main source of data in this study is scientific literature published in Sinta 1, Sinta 2, and Scopus indexed journals. This data source provides the empirical and theoretical evidence needed to delve deeper into the application of deep learning in education. Data sources can be divided into two main categories, namely:

a) Primary sources: The main sources used are journal articles, research results, and reports published in the journals Sinta 1, Sinta 2, and Scopus. These articles provide the latest empirical and theoretical data on deep learning, critical thinking, and basic education.
b) Secondary sources: Textbooks, previous research reports, and literature that expound the theories underlying the application of deep learning in the context of education and the development of critical thinking skills are also used to provide a deeper understanding of the research topic.

The data analysis in this study uses a qualitative approach with content analysis techniques (Sari, 2022). This data analysis technique is carried out in the following way:

a) Categorization and coding: The researcher will identify key themes that emerge in the collected literature, such as deep learning techniques, challenges in improving critical thinking in elementary school, and proposed solutions. Then, the relevant data will be grouped and coded based on those categories.
b) Synthesis of findings: After the literature is grouped, the researcher will synthesize the findings obtained from various sources to draw conclusions and get a comprehensive picture of the problem being studied. In this stage, the researcher will compare and contrast the results of various studies to identify the similarities, differences, and potential gaps that exist.
c) Narrative analysis: The researcher will compile a narrative from the results of the literature analysis that is systematically organized based on the theme or research variable. The research will be guided by relevant theories, such as Vygotsky's theory of constructivism, as well as the application of deep learning in education.

The validity of the data in this literature review research is important to ensure that the sources used are trustworthy and provide valid information (Scott, 2019). Some of the steps taken to ensure the validity of the data are:

a) Source Triangulation: The researcher will use a variety of different sources, including journal articles from journals indexed in Sinta 1, Sinta 2, and Scopus, textbooks, as well as previous research reports. By using diverse sources, researchers can ensure that the findings obtained have a higher validity.
b) Source Verification: Each literature used in this study must be selected from accredited and indexed journals in Scopus or Sinta. These journals have strict review procedures, so it can be ensured that the quality of the research presented in the journals is guaranteed.

Credibility and Relevance Analysis: Researchers will assess the credibility of each article based on the year of publication, the journal's reputation, and the author's affiliation. In addition, the researcher will examine the relevance of the literature to the research topic to ensure that the information used is the most relevant and up-to-date.

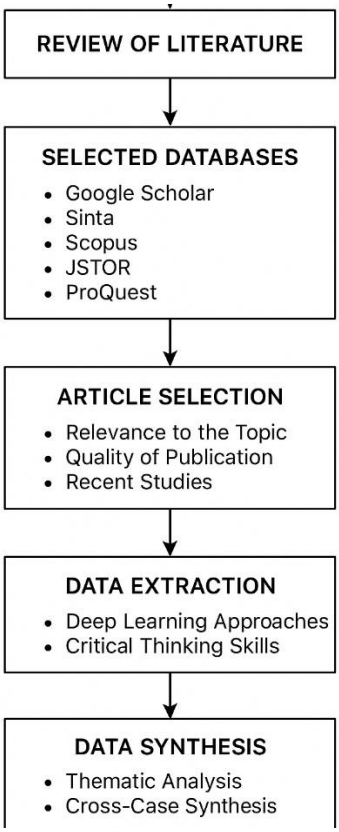

Figure 1. research flow diagram

Result and Discussion

The deep learning approach in education has become an important focus in efforts to improve the quality of learning in Indonesia. Deep learning in the context of education refers to an in-depth, meaningful, and fun approach to learning, which aims to develop students' critical thinking, creativity, and problem-solving skills.

Understanding Deep Learning in Education

Deep learning in education includes deep understanding, knowledge integration, creative application, and higher social engagement (Akmal et al., 2025). This approach emphasizes the importance of active student interaction and the use of technology in supporting more personalized and applicative learning.

Meanwhile, in the context of Indonesian education, the deep learning approach focuses on three main pillars: mindful learning, meaningful learning, and joyful learning. This approach aims to provide a more meaningful, enjoyable, and immersive learning experience for students, as well as enhance essential 21st-century skills in an ever-evolving globalized world (Sandalwood & Sari, 2025).

The deep learning approach in the context of education focuses on achieving deep understanding, knowledge integration, creative application, and social engagement of students. According to Akmal et al. (2025), this approach emphasizes the importance of active student interaction and the use of technology to support more personalized and applicative learning.

Mindful Learning: Mindfulness in the Learning Process

Mindful learning emphasizes the importance of mindfulness in the learning process (Hammill et al., 2023). Students are invited to focus on their current learning experience, observe their thoughts and feelings, and actively reflect on the learning process (A. Putri et al., 2024). This approach helps students develop attention, patience, and self-control, which are essential in effective learning.

In its implementation, mindful learning can be applied through various techniques, such as short meditation before starting the lesson, breathing exercises to improve concentration, and self-reflection activities after learning (Amseke et al., 2024). In addition, creating a calm and distraction-free learning environment also supports the creation of full awareness in the learning process.

Meaningful Learning: Meaningful Learning

Meaningful learning focuses on connecting new knowledge with existing experience or knowledge (Nuriana et al., 2023). Students are encouraged to understand the reasons and relevance of the material being studied in everyday life (Kumar, 2023). This approach helps students see the meaning of what they are learning, thus increasing their motivation and involvement in the learning process (Shobihah et al., 2024).

The implementation of meaningful learning can be done by relating the subject matter to real situations, using examples that are relevant to students' lives, and encouraging students to relate new concepts to their personal experiences (Hafidzhoh et al., 2023). In addition, project-based learning and case studies are also effective in creating meaningful learning experiences.

Joyful Learning: Fun Learning

Joyful learning emphasizes the importance of creating a fun and motivating learning atmosphere for students. Students who feel happy and enthusiastic in the learning process tend to be more active, creative, and have high intrinsic motivation (Hanani et al., 2023). This approach helps reduce stress and anxiety that often hinders the learning process.

To implement joyful learning, teachers can use a variety of methods, such as educational games, creative activities, the use of interactive technology, and creating a positive and supportive classroom environment (Rahma et al., 2022). In addition, providing constructive feedback and appreciation for students' efforts can also increase a sense of joy and satisfaction in learning.

Integration of Mindful, Meaningful, and Joyful Learning in Deep Learning

The integration of these three elements in a deep learning approach creates a holistic and transformative learning experience. Mindful learning helps students focus and be aware of the student's learning process, meaningful learning provides context and relevance, while joyful learning creates a fun and motivating atmosphere (Rosiyati et al., 2025).

The simultaneous application of these three elements can improve students' understanding of concepts, critical thinking skills, creativity, and motivation. In addition, this approach also helps students develop social and emotional skills that are important in daily life.

Expectations of Deep Learning Implementation

By applying the deep learning approach, it is hoped that a more meaningful, fun, and immersive learning experience can be created for students. This will increase student engagement in the learning process, develop 21st century skills, and prepare students for future challenges. In addition, the application of deep learning is also expected to create an inclusive learning environment, support students' social and emotional development, and form positive and adaptive student characters. Thus, deep learning is not just a learning approach, but also an educational paradigm that places students as the center of learning and prioritizes holistic self-development.

The Effectiveness of Deep Learning in Learning

The deep learning approach in education, especially at the elementary school (SD) level, has shown

significant results in improving the quality of learning and developing students' critical thinking skills. Deep learning, in the context of education, is more than just the process of memorizing or acquiring information, but involves deep understanding, the application of concepts in various contexts, and reflection on the learning process itself (Estrada-Molina et al., 2024). This deep learning encourages students to think more critically, creatively, and independently in solving problems.

Research conducted by Akmal et al. (2025), it shows that the application of deep learning approaches has a significant positive impact on concept understanding, long-term retention, as well as the improvement of students' critical thinking and problem-solving skills. Using this approach, students not only remember information, but also relate the information learned to their real experiences. This leads to a stronger and more durable understanding of the material being taught (Putri et al., 2024).

For example, in math and science lessons, where students often focus more on procedures and memorization of formulas, deep learning approaches can help them to better understand the concepts behind those formulas or procedures. A study conducted by Nurhakiki et al. (2024), it shows that deep learning allows students to better understand the basic principles of mathematics and science, not only following mechanical steps, but also being able to apply those concepts in more complex and meaningful situations.

In addition, the deep learning approach has also been proven to increase student involvement in the learning process. Research by Hattie (2009) shows that more in-depth, reflection-based learning has a significant influence on student achievement. One of the main reasons behind the effectiveness of deep learning is its ability to make learning more relevant and contextual for students, which in turn increases their motivation to actively engage in the learning process.

Deep learning also provides opportunities for students to develop better critical thinking skills. In deep learning-based learning, students are not only given information that must be taken for granted, but they are also encouraged to question the information, evaluate its sources, and make rational decisions based on their analysis. In this case, problem-based learning (PBL) plays an important role. PBL, which is one of the methods in deep learning, engages students in solving problems that are real and relevant to their lives. This process requires students to think systematically, identify various solutions, and choose the most appropriate solution based on the data they collect and evaluate.

Project-based learning methods, which are also often used in the context of deep learning, can improve students' critical and collaborative thinking skills. Research conducted by Mutiarani et al. (2024) indicates that students who engage in problem-based projects or collaborative projects are more likely to develop the ability to think critically, share ideas, and work together to find solutions. These projects provide opportunities for students to connect the knowledge they learn with real-world situations, thus creating a more meaningful and relevant learning experience.

On the other hand, while deep learning offers many advantages, its implementation also requires significant changes in teaching approaches and curriculum. Research by Nurhasanah et al. (2025) reveals that while deep learning has the potential to improve students' critical thinking skills, the biggest challenge lies in the implementation of adequate curriculum and teacher training. Many teachers still have difficulty in applying learning methods that focus on problem-solving and reflection (Azzahra et al., 2023). Therefore, to ensure the effectiveness of deep learning, it is important for schools and educational institutions to provide adequate training for teachers.

Another obstacle lies in the resources and facilities available at the school. Project-based learning often requires access to adequate tools and tools, as well as sufficient time to manage those projects. In several studies, it has been found that limited facilities and time are the main barriers to the implementation of deep learning in schools with limited resources (Salmia et al., 2024).

However, despite these challenges, deep learning has still proven to be effective in improving the quality of learning and the development of students' critical thinking skills. Research by Akmal et al. (2025) concludes that with the support of adequate teacher training and the provision of proper facilities, deep learning can be a highly effective approach in education, especially in developing critical thinking skills required in the 21st century.

Thus, although the challenges in its implementation are considerable, deep learning offers a great opportunity to transform education into a more interactive, collaborative, and skills-based 21st century. It is hoped that with this approach, students will not only become smarter academically, but also better prepared to face global challenges with better critical thinking and problem-solving skills.

Challenges in Deep Learning Implementation

While it has many benefits, the implementation of deep learning faces various challenges. One of them is the readiness of teachers in implementing this approach. Teachers need to have a deep understanding of these three elements and the skills to apply them in learning (Aziz et al., 2022).

In addition, limited resources, such as time, facilities, and technology support, are also obstacles in the implementation of deep learning. Therefore, adequate training and support for teachers is needed, as well as the provision of the necessary resources to support the implementation of this approach.

The deep learning approach in education focuses on creating deep, meaningful, and exhilarating learning experiences for students, with the primary goal of improving their critical thinking skills. While this approach has great potential to improve the quality of learning, its implementation in the field faces a number of challenges that need to be overcome in order to achieve these goals. The main challenges that often arise are related to teacher competence, existing curriculum, and adequate support facilities. In this article, we will discuss in detail the various challenges that exist, as well as how they affect the application of deep learning in elementary schools.

One of the main challenges in the implementation of deep learning is the epistemological gap in teacher competence. As found in research by Akmal et al. (2025), many teachers in primary schools still have limitations in the reflective aspects, critical literacy, and philosophical understanding needed to implement this approach effectively. Teachers who do not have a deep understanding of how to develop students' critical thinking tend to rely on more traditional teaching methods, such as lectures and memorization. As a result, the opportunities for critical and reflective thinking offered by deep learning cannot be taken to the fullest.

One of the important aspects of deep learning is the ability of teachers to create spaces for students to question, explore, and question the knowledge they receive (Jufrida et al., 2014). Without sufficient competence in guiding students to think critically, deep learning is difficult to achieve. Therefore, this competency gap can risk distorting the essence of deep learning itself. For this reason, intensive training for teachers in terms of deep learning-based teaching methodologies is needed.

In addition to the problem of teacher competence, another challenge lies in a curriculum that does not support active and skills-based learning in the 21st century (S. Salmia et al., 2020). Deep learning-based learning requires a change from traditional approaches that focus on memorizing and repeating information. In many education systems, including in Indonesia, the existing curriculum tends to still focus on achieving many targets of material and is strictly structured. This risks curtailing teachers' freedom to explore more in-depth and interactive learning methods.

A study by Nurhasanah et al. (2025) shows that the application of deep learning in elementary schools still faces difficulties in adapting the existing curriculum to this approach. An overly dense, exam-oriented curriculum often doesn't make room for the project-based, collaborative, or problem-solving activities that are key in deep learning. This causes students to not get meaningful learning experiences, which are necessary to develop critical thinking skills.

To address this, changes to learning are needed to be more flexible and support learning based on 21st-century skills, such as problem-solving, critical thinking, and collaboration. A curriculum that supports deep learning should provide space for students to actively engage in learning and build their own knowledge.

Overcoming these challenges requires a more integrated effort from all parties involved in education, from the government, educational institutions, to the community. Steps that can be taken include improving teacher training in deep learning, developing a more flexible curriculum, and improving educational facilities and infrastructure.

The Relationship of Electronics Modules to Deep Learning and Students' Collaboration Skills

The integration of electronics modules in deep learning provides significant opportunities to develop students' conceptual understanding, critical thinking skills, and collaborative abilities. The electronics module is a learning medium that combines technology concepts, practical experiments, and real applications in daily life, so that it is in line with the main characteristics of deep learning, namely mindful learning, meaningful learning, and joyful learning. According to constructivist learning theory Vygotsky (1978), students construct knowledge more effectively when actively engaged in hands-on and contextual learning activities, which aligns well with the application of electronics modules.

Electronics Module as a Means of Mindful Learning

In deep learning, mindful learning emphasizes full awareness and focus on the learning process (Rosiyati et al., 2025). The electronics module allows students: a) Observe the working process of the circuit directly (e.g. via sensors, LEDs, or a simple microcontroller). b) Practice precision, patience, and self-control when assembling or programming electronic components. c) Reflect on every step taken, including when the circuit doesn't work as planned, thus building a thorough attitude and process awareness.

This approach corresponds to mindfulness because students learn to be fully present in practicum activities and manage frustration or confusion into a positive learning experience. Research by Cendana et al. (2025) shows that mindful learning practices can increase students' focus, patience, and resilience during complex learning tasks..

Electronics Module as a Meaningful Learning Tool

Meaningful learning occurs when students are able to connect new knowledge with real experiences (Nurhadi, 2020). Electronics module: a) Provide real context for how physics, mathematics, and technology concepts are applied in everyday life (e.g. automatic lights, temperature sensors, or simple security alarms). b) Invite students to solve real problems through the application of science and technology, not just memorize theories. c) Encourage students to understand the relevance of learning to future needs, including technology-based 21st century skills. Thus, the knowledge gained is not only theoretical, but also has practical and applicative value. Studies by Fitriyah et al. (2022) highlight that project-based learning, when applied in STEM contexts, fosters deeper understanding and problem-solving skills.

Electronics Module to Create Joyful Learning

One of the learning challenges in elementary school is maintaining students' interest and enthusiasm. The electronics module provides: a) A fun learning experience through exploratory activities and interactive experiments. b) A sense of achievement when an electronics project is successfully implemented, for example designing *a mini project* in the form of an automatic door alarm or light sensor light. c) A learning environment that is free from the boredom of traditional lecture methods.

This creates a learning atmosphere that motivates students to continue exploring. According to Csikszentmihalyi's Flow Theory, students experience greater motivation and engagement when involved in challenging yet enjoyable learning (Djau et al., 2017).

Improvement of Collaboration Skills through Electronics Module

Deep learning emphasizes collaboration between students (Johnson, 2009), and the electronics module supports this through: a) Teamwork during assembly and programming: students share tasks, such as reading circuit diagrams, putting together components, and testing their functionality. b) Group discussions for problem solving: when the series doesn't work, students learn to identify common mistakes, propose solutions, and make collaborative decisions. c) Joint reflection: once the project is complete, students evaluate their teamwork processes, what is going well, and what needs to be improved.

Activities like this develop important soft skills: communication, empathy, conflict management, and productive cooperation.

Integration of Electronics Modules in the Framework of Deep Learning

When electronics modules are integrated with a deep learning approach: a) Students not only receive information, but construct knowledge through hands-on experience (Nurhadi, 2020). b) The learning process becomes student-centered learning, not the teacher (Piaget, 1952). c) Critical thinking skills develop, as students must analyze technical problems, test hypotheses, and make data-driven decisions (Facione, 2011). d) Collaborative skills are increasing, as electronic project-based learning is almost always done in teams.

This is in line with the findings of the study (Mutiarani et al., 2024; Nurhakiki et al., 2024) which show that the use of technology-based projects in deep learning strengthens 21st century skills, including collaboration, critical thinking, and creativity.

Conclusion

This study explores the application of deep learning in elementary education and its relationship with the use of electronics modules to enhance students' critical thinking, collaboration, and overall learning experience. Deep learning in education focuses on creating meaningful, mindful, and joyful learning experiences, aiming to improve concept understanding, problem-solving skills, and engagement in learning. The integration of electronics modules serves as an effective medium to implement deep learning principles. These modules allow students to engage in hands-on experiments, apply concepts in real-life contexts, and work collaboratively on technology-based projects. The use of electronics modules promotes active participation, increases motivation, and helps students develop practical skills relevant to modern education. The study found that this approach improves students' conceptual understanding, enhances their ability to connect theoretical knowledge with real applications, and fosters an enjoyable learning environment. It also strengthens collaboration through teamwork in assembling, programming, and testing circuits, as well as problem-solving discussions and joint reflection. Despite its benefits, challenges remain in implementing deep learning effectively, including the need for teacher readiness, adequate training, curriculum adaptation, and sufficient resources. Addressing these challenges will enable a more interactive, student-centered learning process and support the development of essential 21st-century skills.

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