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Integration of Deep Learning Approach In Developing Innovative Teaching Behavior of Elementary School Teachers

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Abstract. *This study aims to explore the integration of deep learning approaches in developing innovative teaching behaviors among elementary school teachers. The background of research stems from the need to improve the quality of learning through adaptive, creative, and technology-based teaching strategies. The research method used was an exploratory qualitative approach through interviews, observations, and documentation studies. The results indicate that the implementation of deep learning integration has not been optimally implemented. This is due to limited teacher competency in understanding the concept of deep learning, minimal technological infrastructure support, resistance to change, and suboptimal support from school principals. Other obstacles that arise are limited infrastructure and teacher resistance to changes in learning patterns. This study recommends the need for ongoing training programs, school policy support, and intensive mentoring so that deep learning integration can be effective in developing innovative teaching behaviors among teachers.*

Keywords: *Deep Learning Approach, Behavioral Development, Innovative Teachers*

1. Introduction

Indonesia faces numerous future challenges that demand serious preparation in the education sector. These challenges include a society that will become increasingly complex, dynamic, uncertain, unpredictable, and ambiguous, heavily influenced by developments in science and technology (Fatmawaty, 2024). At the same time, society will become increasingly diverse and therefore vulnerable to conflict. Therefore, education in Indonesia needs to immediately prepare students to be independent, able to face challenges, overcome obstacles, and even become agents of change that bring benefits to society, the nation, and humanity (Santiani, 2025). Indonesia's young generation needs to be educated to be resilient in facing challenges and resolving conflicts, adaptive, and possessing a growth mindset to deftly capitalize on opportunities, be able to accept criticism, and believe in their potential and talents for development.

21st-century education demands that teachers master innovative learning skills. One approach considered relevant is deep learning, which focuses not only on artificial intelligence technology but also refers to an in-depth learning process that emphasizes understanding, reflection, and the interconnectedness of concepts (Fullan & Langworthy, 2014).

Indonesia has been relatively successful in increasing access to primary and secondary education, as indicated by the gross enrollment rate (APK) for basic education (compulsory education), namely 104.97% for elementary school and 90.67% for junior

high school (BPS, 2024). However, education in Indonesia currently still needs to address several issues related to quality, including the low reading literacy and numeracy scores (mathematical literacy) of Indonesian students as reflected in the results of the Program for International Student Assessment (PISA). PISA data shows that literacy and numeracy of Indonesian students are still below the international average (Mathematics: 472, Science: 485, Reading: 476). Indonesia is ranked 68th out of 81 countries with scores: mathematics (379), science (398), and reading (371) (OECD, 2023).

Basic education plays a strategic role in establishing the foundation of students' knowledge, attitudes, and skills. As the spearhead of education delivery, teachers are required to not only deliver learning materials but also to deliver creative, contextual, and meaningful learning processes. In this context, innovative teaching behaviors are a crucial factor in encouraging active student engagement and fostering critical thinking, collaborative thinking, and problem-solving skills from an early age (Diputera et al., 2024).

However, in reality, many elementary school teachers still face limitations in developing innovative teaching behaviors. Some common obstacles encountered include limited use of technology, the dominance of lecture methods, a lack of exploration of new ideas in the learning process, and limited training oriented towards developing innovative pedagogy (Hariyanti, 2024). These conditions often cause the teaching and learning process to be monotonous and do not provide space for the optimal development of student potential. Many elementary school teachers still face challenges in developing innovative teaching behaviors. These obstacles can include limited understanding of the concept of deep learning, a lack of skills in utilizing educational technology, and minimal support from the school environment (Liu & Zaman, 2025). These conditions impact on the low quality of learning, especially in fostering creativity, independence, and higher-order thinking skills in students (Purwanto et al., 2024).

The development of digital technology in the Industrial Revolution 4.0 era has brought significant changes to the world of education. The learning process is no longer solely oriented towards knowledge transfer but also demands 21st-century skills such as critical thinking, creativity, collaboration, and communication. As the spearhead of education, teachers are required to deliver innovative, adaptive, and contextual learning so that students develop competencies relevant to current developments (Ningrum & Abdullah, 2021).

One approach that can support the achievement of these goals is deep learning. The concept of deep learning in an educational context focuses not only on the use of artificial intelligence technology but also emphasizes meaningful learning, where students are guided to understand, analyze, and connect knowledge to real-world situations (Feng & Xiao, 2024). Teachers who integrate this approach are required to shift their teaching behavior from traditional, teacher-centered patterns to innovative, student-centered learning patterns.

The urgency of implementing a deep learning approach is increasing along with the demands of 21st century competencies by expanding the concept of deep learning by identifying six key competencies called 6 C; Character, Citizenship, Collaboration, Communication, Creativity, and Critical Thinking (Ahmad Turmuzi, 2025). The implementation of deep learning has experienced a significant increase in learning motivation and the development of high-level thinking skills (Wijaya et al., 2025).

The deep learning approach is a learning system designed to strengthen students' understanding through an in-depth approach. The deep learning approach emphasizes a

learning process that involves critical analysis, linking information to prior knowledge, and applying it in broader contexts. The goal is to create reflective learning that is meaningful, enjoyable, critical, and deeper (Khotimah & Abdan, 2025).

The deep learning approach emphasizes three conceptual pillars: 1) mindful learning, which recognizes that each student has a different background and learning style, necessitating increased interaction and positive relationships between teachers and students (Deng et al., 2024). Teachers must fully respect and not neglect their students. Humans have different ways of thinking, and therefore, each student's thinking style is also different. 2) Meaningful learning, which fosters a meaningful learning process that encourages students to think critically, engage actively in each learning activity, and understand the meaning concretely and deeply. 3) Joyful learning, which fosters a pleasant learning experience and a fun and relevant learning environment. This joy is felt because students feel valued, are able to do things on their own, and can discover new things and find new meaning in the material they learn (Diputera et al., 2024).

Previous research results revealed that the integration of deep learning approaches requires a restructuring of the approach that focuses on real-life experiences and the development of critical thinking skills, emphasizing the importance of creating an exploratory and reflective learning environment and implementation challenges such as system unpreparedness, limited resources, and lack of teacher training, being significant obstacles in the implementation of deep learning approaches (Isnayanti et al., 2025).

Deep learning in education encompasses deeper understanding, knowledge integration, creative application, and enhanced social engagement. This approach emphasizes the importance of active student interaction and the use of technology to support more personalized and applicable learning. The implications of these findings suggest that the application of deep learning can improve the quality of education and provide more transformative learning experiences for students, as well as strengthen real-world skills (Akmal et al., 2025).

The purpose of this study is to explore the potential of integrating a deep learning approach in developing innovative teaching behaviors for teachers in schools by analyzing and describing how the integration of a deep learning approach can contribute to the development of innovative teaching behaviors for elementary school teachers. Through this approach, teachers are expected to not only master learning materials but also create adaptive, creative, and student-centered learning strategies. Furthermore, this study aims to uncover the opportunities and challenges of implementing deep learning in improving teachers' professional competence, thereby supporting the achievement of better-quality education that is relevant to the demands of the digital era and the 21st century.

The integration of deep learning approaches is expected to be a solution for encouraging innovative teaching behaviors. Teachers can develop learning strategies that emphasize the exploration of ideas, collaboration, and the use of technology relevant to students' needs. Thus, the application of deep learning not only improves the quality of learning but also strengthens teachers' professionalism as agents of change in primary education.

This study seeks to answer the following research questions. How do elementary school teachers understand the concept of deep learning in the learning process? How is the deep learning approach applied by teachers in classroom learning to develop innovative teaching behavior? What obstacles do teachers face in implementing deep learning to support innovative teaching behavior? How do school principals support

teachers in implementing deep learning approaches in schools?

2. Method

This study employed a descriptive qualitative approach to explore transformational leadership and innovative teaching behavior in elementary schools in Aceh Besar Regency. This approach was selected because qualitative data enable an in-depth depiction of complex social realities, allowing social phenomena to be understood in a concrete and contextual manner (Creswell, 2014).

The participants consisted of six school principals and twelve teachers from six elementary schools, selected through purposive sampling. Principals had served in their positions for at least one academic year, while teachers had a minimum of two years of teaching experience.

Data were collected through in-depth interviews, participant observation, and documentation studies. Semi-structured interviews were conducted to examine principals' transformational leadership practices and teachers' experiences in implementing innovative teaching. Participant observations focused on classroom instruction, school meetings, and daily school interactions, and were recorded using observation guidelines and field notes. Documentation studies involved the analysis of school policies, lesson plans, supervision records, and professional development documents.

Data analysis followed an interactive model comprising data reduction, data display, and conclusion drawing with verification. Interview data were coded and thematically analyzed, observation data were examined to identify behavioral patterns, and documentation data were used to support and validate findings from interviews and observations. Data triangulation and member checking were employed to ensure the trustworthiness of the findings.

3. Results and Discussions

Research result

The interview results revealed that the integration of deep learning approaches in elementary school teaching has not been optimally implemented. Most teachers demonstrated a limited understanding of deep learning as a pedagogical concept and tended to associate it solely with artificial intelligence technology rather than as an approach emphasizing meaningful, reflective, and student-centered learning.

Several teachers reported having participated in training programs related to learning reform that introduced the concept of deep learning. However, these training sessions were predominantly theoretical and lacked practical components, such as classroom simulations, model lesson plans, or concrete implementation guidelines. As a result, teachers experienced difficulties translating conceptual knowledge into instructional practice.

Teachers who had attended training generally understood deep learning as an approach that promotes in-depth conceptual understanding, critical thinking, and knowledge integration. Nevertheless, they expressed confusion when attempting to apply these principles in classroom settings due to the absence of clear instructional models and continuous mentoring. Interview data also indicated that teachers perceived the training materials as abstract and insufficient to support changes in teaching behavior.

In addition, interviews with school principals revealed that although principals encouraged teachers to participate in professional development activities, support for

implementing deep learning was limited to general directives. Systematic mentoring, instructional supervision focused on teaching quality, and structured follow-up programs were largely absent.

Classroom observations supported the interview findings. Although teachers verbally acknowledged the importance of fostering deep understanding and higher-order thinking skills, observed teaching practices remained largely conventional. Instruction was predominantly teacher-centered, relying on lectures, question-and-answer sessions, and routine exercises.

Observed lessons showed limited integration of contextual learning, reflective activities, or project-based learning, which are key characteristics of deep learning. Teachers rarely connected lesson content to students' real-life experiences or encouraged collaborative problem-solving activities. Furthermore, the use of digital media and technology was minimal, even in schools where basic technological facilities were available.

Observations of school meetings and daily interactions also indicated that discussions about instructional innovation were infrequent. Professional dialogues focused more on administrative compliance than on improving the quality of learning processes.

Documentation analysis further confirmed the findings from interviews and observations. Review of lesson plans (RPP) showed that most instructional designs did not incorporate elements of reflective learning, collaboration, or project-based activities. Learning objectives were generally focused on content coverage rather than conceptual understanding or skill development.

School work programs and supervision documents indicated that teacher professional development activities were primarily oriented toward routine administrative requirements, such as curriculum updates and learning documentation. There was little evidence of structured planning related to the development of deep learning practices or innovative teaching behavior.

These findings suggest a gap between policy documents, training programs, and classroom implementation, indicating that theoretical exposure to deep learning has not yet translated into consistent instructional practice.

Based on research results, it was found that the integration of deep learning approaches into teacher learning in elementary schools in several schools in Aceh Besar has not yet been integrated. Most teachers lack a thorough understanding of the concept of deep learning in a pedagogical context. They still associate it solely with artificial intelligence technology, rather than as a deep learning philosophy. This leads to confusion in designing appropriate teaching strategies.

Some elementary school teachers have participated in training on learning reform, which includes the concept of deep learning. However, this training was purely theoretical, providing an explanation of general concepts and materials, without providing opportunities for hands-on practice in the classroom.

Teachers who have participated in training report understanding deep learning as in-depth learning that emphasizes conceptual understanding, critical thinking skills, and connections between knowledge. However, they still experience confusion when it comes to implementing it in real-world practice. This is due to the lack of concrete examples, lesson plan models, or practical guidance to serve as references.

In interviews, several teachers expressed that the training materials felt abstract. They were given explanations about the importance of deep learning in developing

innovative teaching behaviors, but were not provided with simulations, case studies, or guidance on designing learning steps. As a result, teachers lacked the practical skills to transform conventional teaching patterns into deep learning-based ones.

Classroom observations also reinforced these findings. Although teachers acknowledged that learning should foster deep understanding and higher-order thinking skills, their practices were limited to Q&A sessions, lectures, and practice exercises. Teachers were unable to connect the subject matter to students' real-life contexts or develop project-based learning models, which are hallmarks of deep learning.

A documentary study of lesson plans (RPP) revealed a similar finding. The lesson plans created by teachers did not incorporate reflective, collaborative, or project-based learning strategies. This confirms that the theoretical knowledge gained from training is insufficient to transform teaching behaviours to become more innovative.

Thus, it can be concluded that the mismatch between theoretical training materials and practical classroom needs is a major obstacle for teachers. They understand the general concept of deep learning but are confused and unable to implement it in their daily learning process.

Teachers tend to stick to conventional teaching methods. Age, old habits, and fear of failure make deep learning-based innovations difficult to implement. Although the results have not been successful, several initiatives have been implemented, such as basic training on digital applications, collaboration between teachers, and trials of reflective teaching methods. However, these efforts have not yet reached the stage of consistent implementation.

In addition to teacher competency, this study also found that principals' support for the implementation of deep learning was suboptimal. Interviews revealed that principals had encouraged teachers to participate in training and develop innovative learning strategies. However, this support was limited to general guidance and was not accompanied by systematic mentoring.

Several teachers reported that the principal had not yet established a dedicated forum for sharing best practices related to deep learning. Supervision focused more on administrative aspects, such as the completeness of learning materials (lessons plans, teaching journals, and activity reports), rather than evaluating the quality of deep learning occurring in the classroom. This led teachers to feel that learning innovation, including the integration of deep learning, was not a top priority for the school.

Documentation of school work programs also shows that agendas related to developing deep learning or innovative learning are not yet clearly planned. Teacher professional development activities are more focused on routine programs, such as curriculum workshops or learning administration.

Thus, it can be concluded that principals play a crucial role in fostering a culture of innovation in schools, but this role has not been fully implemented. Lack of mentoring, a lack of targeted policies, and a predominant focus on administration mean that deep learning implementation has not received full support from school management.

Innovative teaching behavior is reflected in a teacher's ability to explore new ideas, creatively utilize digital media, and connect material to students' real-life contexts. Teachers should also demonstrate the courage to try alternative strategies that meet learning needs.

The main obstacles include teachers' limited digital competency, a lack of technological infrastructure in some schools, and limited time to design deep learning-based instruction. Furthermore, some teachers still tend to be comfortable with

conventional methods, making them less open to innovation. Not all teachers have a good grasp of educational technology. Some elementary schools still lack ICT facilities, particularly in rural areas.

Discussion

Teachers still interpret deep learning as an AI technology term, not a pedagogical approach. For example, some teachers assume that deep learning can only be implemented with sophisticated computer applications. As a result, they don't try to integrate elements of reflection, problem-solving, or project-based learning.

Limited facilities are a real obstacle. Elementary schools in rural areas have only a few computers, internet access is unstable, and projectors are rarely used. Without the necessary infrastructure, integrating deep learning is difficult to achieve.

Long-tenured teachers tend to stick to traditional methods. They feel that lectures and question-and-answer methods are more practical than trying new approaches. There is also a fear that using innovative methods could lead to students becoming uncontrollable.

Government-provided training is often one-way, focused on technical material, and lacks sustainability. Teachers receive neither intensive practice nor post-training supervision. This results in the acquired skills not being translated into consistent teaching behavior. Some teachers have begun experimenting with small project-based learning strategies (e.g., creating environmental posters or simple experiments). However, due to minimal support, these activities are only occasional and have not yet developed sustainable innovative teaching behaviors.

This finding aligns with Sergiovanni's (2001) view that educational leadership should focus not only on administrative control but also on creating a school climate conducive to innovative learning. However, in reality, principals place more emphasis on the completeness of documents such as lesson plans, teaching journals, and routine reports, leaving teachers feeling that learning innovation is not a top priority.

However, the identified obstacles highlight the need for strategies to improve teacher capacity, particularly in digital literacy and time management. Without ongoing training, teachers could potentially revert to conventional methods that are less suited to the demands of 21st-century learning. This finding echoes research findings (Mas'ud & Malik, 2025), which state that integrating deep learning approaches requires strengthening teacher capacity, technological support, and policies that encourage reflective and exploratory learning. These findings underscore the importance of hands-on, hands-on training and the provision of adaptive learning resources in schools.

In line with this, the results of research conducted by (Turmuzi, 2025) also show that challenges in implementing deep learning in education still include access to technology, teacher readiness and policies that support digital transformation in the education system.

Thus, it can be concluded that the successful implementation of deep learning depends not only on the availability of technology but also on the readiness and competence of teachers, supported by ongoing training and responsive policies. Collaborative efforts between schools, the government, and other stakeholders are key to realizing a more meaningful and relevant learning transformation for students in the digital age.

4. Conclusions

This study concludes that the integration of deep learning approaches into developing innovative teaching behaviors among elementary school teachers has not been successfully implemented. This is influenced by teachers' limited understanding of the meaning of deep learning, technological infrastructure constraints in elementary schools, teacher resistance to changes in teaching patterns, and a weak system of ongoing mentoring and training.

Teachers still struggle to understand deep learning as a comprehensive learning approach. Most associate the term with artificial intelligence, rather than as a pedagogical strategy that emphasizes reflective understanding, conceptual connections, and problem-solving-based learning. Teacher resistance to changes in teaching methods remains high. Age, old habits, and fear of failing to innovate make teachers more comfortable with traditional methods such as lectures and practice exercises.

The training and mentoring system is inadequate. Teacher training is largely formal, discontinuous, and lacks follow-up supervision, making it difficult to foster innovation in teaching habits. While efforts such as the use of small project-based learning have been made, this integration is inconsistent and remains fragmented. As a result, teachers' innovative teaching behaviors have not yet fully developed.

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