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Development of Deep Learning Methods to Improve Reading Skills for Elementary School Students

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ABSTRACT

This study aims to present an in-depth analysis of the potential application of Deep Learning learning methods in improving reading literacy skills for elementary school students who face reading barriers. This literature review explores the application of Artificial Intelligence (AI)-based Deep Learning in the context of education, identifies the challenges faced by learners with reading difficulties, reviews existing teaching strategies, and researches case studies of Deep Learning implementation. In addition, this review literature discusses Deep Learning architectures relevant to natural language processing, the steps of developing and evaluating Deep Learning-based learning systems, ethical and practical considerations, and the resources and tools available. Key findings highlight the potential of Deep Learning in personalizing learning, providing intelligent guidance, automating assessments, and adaptive learning material generation. However, successful implementation requires careful consideration of pedagogical, ethical, and practical factors, as well as investment in teacher training and adequate infrastructure. With the Development of Deep Learning Learning Methods, it is hoped that early evaluation and implementation at the elementary school education level will be one of the keys to timely intervention and prevention before taking root and causing significant academic challenges in the future for students.

Keywords : *Deep Learning Learning; Learning Model*

1. Introduction

The significance of reading literacy in basic education reading ability is a fundamental skill that is very important for academic success and lifelong learning. Strong literacy in primary schools lays the foundation for comprehension in all subjects and empowers individuals to participate fully in society(Saryanto et al., 2024; Ali et al., 2024; Dewanto et al., 2023; Ichsan et al., 2023; Zulyusri et al., 2023). The ability to decode text, understand its meaning, and think critically about what is read is essential for cognitive development and personal growth. In this digital age, the concept of reading literacy has expanded beyond traditional print media to include online platforms, which demand the ability to navigate diverse sources of information, distinguish between facts and opinions, and actively build understanding(Muhitida et al., 2020). Fundamentally, literacy is the ability to read and write, but the modern understanding of literacy has evolved from simply letter and word recognition to a more comprehensive social practice. Some experts define reading literacy as an ongoing process in which readers with rich literacy experience regularly read books, enjoy the activity, accumulate relevant knowledge, and reflect on the material they have read (Campbell et al., 2001).

The Progress in International Reading Literacy Study (PIRLS) defines reading literacy as the capacity to understand and use various forms of written language that are valued by individuals and needed by society, in which readers actively construct the meaning of different types of texts for the purposes of learning, participating in community of readers, and for recreation (Liu et al., 2020; Epik et al., 2025)From some definitions it underlines that reading literacy is a multidimensional construct that involves more than just the ability to decode words, but it also involves deep understanding, active engagement with the text, and the

ability to use information obtained in a variety of contexts(Grover et al., 2015). Furthermore, reading literacy includes both reading techniques and understanding of reading content, including oral comprehension, developing positive relationships with reading activities, forming good reading habits, and growing intrinsic motivation to read for the development of students (Bal & Öztürk, 2025; Oktarina et al., 2021; Rahman et al., 2023; Uluk et al., 2024; Youna Chatrine Bachtiar et al., 2023)

While the importance of reading literacy is undeniable, recent studies show a decline in literacy levels among Indonesia's young generation, a worrying trend given the vital role of this skill in promoting critical thinking and active participation in community life(Hu et al., 2023). In the Policy Minutes document No. 3 of the Language Development and Development Agency, it is explained through several data and indicators that show the actual condition of students' literacy skills in Indonesia (Ashari, 2024; Suyatmo et al., 2023)

Traditional teaching methods often struggle to accommodate the diverse needs of students in terms of reading comprehension. Furthermore, the inability to read well can significantly hinder an individual's academic progress and reduce their capacity to interact effectively with various aspects of life(Asnur et al., 2024; Elfira & Santosa, 2023). Challenges in reading literacy skills for students face challenges in learning to read, with estimates suggesting that most students may require additional support beyond traditional learning. This highlights that learning to read is not a uniform process and many students require a tailored approach. These difficulties can stem from a variety of interrelated factors, including fundamental issues with phonemic awareness (the ability to recognize and manipulate individual sounds in spoken words), decoding (the process of translating printed letters into sounds), fluency (reading smoothly and accurately at an appropriate speed), and comprehension (understanding the meaning of the text) (Roberts & Roberts, 2008; Ma et al., 2023).

Early identification of these difficulties is crucial because research shows that interventions are most effective when implemented early in a child's educational journey, potentially preventing more significant reading problems later on (Jenkins & O'Connor, 2002). This decline in literacy rates, coupled with the limitations of conventional teaching approaches, indicates an urgent need for innovative approaches to improve reading skills, and this is where advanced technologies such as Deep Learning have the potential to play a transformative role(Hussain et al., 2023; Zulkifli et al., 2022). Deep learning in academic texts Deep learning is defined as an approach that emphasizes the creation of a learning environment and learning process that is conscious, meaningful, and enjoyable through holistic and integrated intellectual, emotional, sensory, and physical engagement (Suyanto, 2025). This approach aims to promote deep understanding, the application of knowledge in real-world contexts, and the development of higher-order thinking skills and character in learners.

Deep Learning in the context of Artificial Intelligence (AI) refers to machine learning algorithms inspired by the structure of the human brain, which are capable of analyzing complex data and identifying patterns without the need for manual feature engineering(Luciana et al., 2024). In education, Deep Learning can personalize learning, provide adaptive education, monitor learning behavior, and support intelligent evaluation systems (Cao, Yong & Sun, Yongke., 2024). In this context, Deep Learning models can analyze student learning data to understand their learning styles, characteristics, and levels of understanding, enabling the creation of customized learning materials and plans. Through this process, Deep Learning models become capable of recognizing complex patterns in various types of data, including images, text, sound, and others, to generate accurate insights and make reliable predictions.

It is important to distinguish between Deep Learning in the context of Artificial Intelligence (AI) and pedagogical concepts. Artificial Intelligence (AI)-based deep learning refers to the use of artificial intelligence algorithms to process data and identify complex patterns, which can be applied in personalized learning or automated assessment(Sanusi et al.,

2023). On the other hand, the pedagogical approach to Deep Learning focuses on developing students' abilities to think critically, solve complex problems, communicate effectively, work collaboratively, and learn independently (Cao, Yong & Sun, Yongke., 2024). Although different, these two concepts are not mutually exclusive. Deep learning tools based on Artificial Intelligence (AI) can be designed to support deeper learning objectives, for example by providing personalized learning experiences that encourage learners to engage with the material at a higher level. Research conducted by Zhang et al. (2022) shows that the deep learning approach in education is able to improve reading comprehension through the adaptation of learning materials tailored to individual students' abilities(Psyridou et al., 2024). By utilizing artificial intelligence algorithms, the learning system can recommend reading texts that are appropriate to students' literacy levels, provide automatic feedback, and detect reading difficulties early. This approach not only supports personalized learning, but also encourages students' active participation in exploring reading texts independently and meaningfully. This is particularly relevant at the primary school level where the need for a fun and adaptive approach is crucial in building the foundations of early literacy (Santosa, 2025; Utomo et al., 2023).

In addition, a study conducted by Rahman and Hidayat (2021) in the context of technology-based learning in elementary schools shows that the use of intelligent systems that apply deep learning principles can increase students' absorption of vocabulary and language structure. The study integrates speech recognition and natural language processing (NLP) models to provide students with an interactive reading experience, which has been shown to be effective in increasing motivation and reading interest. Thus, the development of deep learning-based learning methods can be a strategic alternative in supporting better and sustainable mastery of reading skills, especially in the digital era that demands learning that is responsive to the needs and characteristics of students (Jiang et al., 2024).

This literature review aims to provide an alternative to traditional learning and the need for more individualized and responsive methods through Deep Learning. Different instructional potentials and personalized learning paths to meet the diverse needs of learners. The transformative role of technology and Artificial Intelligence (AI) in providing a personalized learning experience and identifying reading difficulties. Further, the effectiveness of reading interventions using Artificial Intelligence (AI) in early intervention is very important for students at risk of reading difficulties, especially in language subjects and students with learning disabilities. Identifying reading difficulties and conducting early evaluations in elementary school education is key to timely intervention and prevention programs before they become entrenched and cause significant academic challenges in students' futures.

2. Research Methods

This research method is based on a literature review with a qualitative approach. This type of research uses a qualitative approach. The target of this research is elementary school students who face challenges in reading skills. The procedure for this research will follow the steps of the literature review, namely; (1) identify and collect relevant literature from various sources such as academic journals, books, and research publications; (2) evaluate the quality and relevance of the collected literature; and (3) analyze and synthesize information from the literature to identify key themes, patterns, and knowledge gaps related to the application of *Deep Learning* to improve the reading ability of elementary school students.

The data used in this study are secondary data sourced from relevant literature. This data includes research findings, theories, models, and concepts related to Deep Learning, reading literacy, and reading learning challenges in elementary schools. The main instrument in this study is the researcher himself as a key instrument. Researchers will use the literature review guide to facilitate the data collection, evaluation, and analysis process. The data

collection technique used is a documentation study, which is to collect and study relevant literature documents. The data analysis technique that will be used is content analysis or thematic analysis. The steps in data analysis include; (1) reading and understanding the content of the collected literature; (2) identify important and relevant themes to the research focus; (3) classify and group information based on themes that have been identified; (4) synthesize and interpret findings from the literature to answer research questions and achieve research objectives; and (5) related sources and content.

3. Result and Discussion

This Based Literature review aims to provide a comprehensive overview of the challenges in reading literacy skills faced by elementary school students. Its scope includes deconstructing the components of reading, identifying contributing factors, evaluating traditional instruction, and exploring differentiated and technology-enhanced solutions, with a focus on the Indonesian context. This literature review emphasizes the need for an improved support system and a tailored approach to improve reading outcomes for all learners. To conduct an intervention and early evaluation, teachers deconstruct the core components of reading literacy in detail on the following aspects.

1. Phonemic Awareness: The Foundations of Voice Recognition and Manipulation

Phonemic awareness is the ability to identify, manipulate, and distinguish individual sounds (phonemes) in spoken words that are important predictors of reading success and are necessary for learning and using alphabet codes (National Reading Panel, 2000). Instruction in phonemic awareness is beneficial for beginner readers and spellers. A strong foundation in phonemic awareness is fundamental to decoding and the development of reading as a whole. Deficiencies in this area can lead to significant reading difficulties (National Institute for Literacy, 2000). Research has consistently identified phonemic awareness as a core prerequisite for reading. Without the ability to recognize and manipulate sounds, learners have difficulty associating these sounds with letters, hindering their ability to decode words (Parrott & Cherry, 2011).

Phonemic awareness is a basic ability in phonological awareness that refers to an individual's awareness of the smallest sounds in a language, called phonemes. This skill is essential in the development of early literacy because it allows learners to recognize, identify, and manipulate sounds in spoken words before understanding their written form. Research shows that phonemic awareness is a strong predictor of children's reading and writing skills, especially in the process of decoding and word recognition. Without mastery of phonemes, children will have difficulty in connecting written symbols with spoken sounds, which has an impact on delaying literacy development.

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2. Decode: Translating Prints into Voices and Their Role in Word Recognition

Decoding is the process of translating printed letters into sound to read words (Scarborough, H. S., 2001). Decoding involves understanding letter-sound correspondence and using this knowledge to read known and unknown words. Difficulties in phonics and decoding can be the root cause of problems with reading words fluently (Moats, L. C., 1998). Effective

decoding skills are essential for accurate and fluent reading. Weaknesses in decoding can significantly affect reading comprehension, even if language comprehension is strong. A Simple View of Reading highlights decoding as a key component of reading comprehension (Gough, P. B., & Tunmer, W. E., 1986). If learners can't decode words accurately, their ability to understand the text will be impaired. Decoding skills are a basic skill in reading that refers to the process of connecting written symbols (letters or graphemes) with appropriate sounds (phonemes), thus allowing individuals to convert text into sounds. This process is phonological, in which the novice reader actively breaks down words into sound units to form meaning. According to Ehri (2005), *decoding* is an important stage in the development of early literacy because it strengthens the relationship between spelling and pronunciation, which is the foundation of word *recognition*. When students can decode fluently, they will be faster to recognize words automatically without having to analyze them individually (Worthy et al., 2018).

In the context of the cognitive development of elementary school-age children, decoding acts as a bridge to *sight word recognition*, which is the ability to recognize words instantly without having to spell them. This process is very important because speed and accuracy in word recognition have a direct impact on the fluency of reading and comprehension of the text. Stanovich (1986) stated that readers who have good decoding skills tend to experience faster vocabulary growth, because they are better able to understand new words through the context of reading. Therefore, teaching interventions that focus on decoding training such as systematic phonics have been shown to be effective in improving reading skills in learners (Sanusi et al., 2023)

With advances in educational technology, decoding can now be improved through the use of *speech* recognition-based and *text-to-speech* applications. This system allows students to hear back the words they read, reinforcing the connection between text and sound in a multisensory way. Research by Dalton and Grisham (2011) shows that the integration of technology in decoding exercises can increase students' motivation and involvement in reading learning, especially for students with learning difficulties. By combining traditional and digital approaches, the decoding process becomes not only a mechanical activity, but also an interactive experience that supports automatic and continuous word recognition (Santosa & Sepriyani., 2020).

3. Fluency: The Interaction of Accuracy, Speed, and Prosodi in Meaningful Reading

Fluency refers to the ability to read text accurately, quickly, and with proper expression (Scarborough, H. S., 2001). Fluency involves automatism in word recognition, comprehension, and prosody (Ehri, L. C., Nunes, S. R., Stahl, S. A., & Willows, D. M., 2001). Reading fluently allows learners to focus on comprehension rather than word recognition (Kuhn, M. R., & Stahl, S. A., 2003). Reading fluency acts as a bridge between decoding and comprehension. Learners who read fluently can allocate more cognitive resources to understanding the meaning of the text. Research shows that fluency isn't just about speed; It also involves accuracy and expression, all of which contribute to better understanding. Slow and influent reading hinders the ability to understand meaning. Fluency or reading fluency is an important component in literacy development, which includes three main elements: accuracy, speed, and prosody(Psyridou et al., 2024). Accuracy refers to the reader's ability to recognize words precisely, while speed reflects fluency in reading without unnecessary pauses. Prosody, as a suprasegmental element, refers to the intonation, pressure, and pause used in oral reading, which reflects the understanding of the meaning of the text. The three interact dynamically to create a meaningful and immersive reading experience (Rasinski, 2012).

Research shows that students who have high reading fluency tend to have better reading comprehension. This is because good fluency allows the brain to allocate its cognitive resources not only to decoding words, but to build an overall understanding of the text. According to Kuhn et al. (2010), when students read accurately and quickly with the right

expressions, they are better able to capture the narrative structure, emotions in the text, as well as the interconnectedness between information, which supports retention and inference. Therefore, reading fluency is not just a mechanical skill, but a reflection of complex cognitive processing. Prosodi is often an indirect indicator of text comprehension. Students who read with appropriate intonation and pauses show that they understand the content of the reading and can interpret the meaning contextually. Developing prosody through repetitive reading exercises and performative-based learning (such as reading poetry or drama) has been shown to be effective in improving reading fluency and at the same time strengthening comprehension skills (Zutell & Rasinski, 1991). This approach also strengthens the relationship between verbal expression and meaning, thus making reading a more lively and communicative activity.

The integration of audio and video-based learning technology also supports the development of fluency. Digital learning apps that provide expressive reading models and provide immediate feedback on students' speed and accuracy can accelerate the progress of overall reading skills. For example, the use of software that records students' voices and provides a procedural analysis helps teachers and students to identify specific aspects that need improvement. Thus, an approach that combines cognitive-based and technology-based training can be an effective strategy to establish optimal fluency in novice readers (Yang, 2022).

4. Comprehension: The Main Purpose of Reading – Understanding and Interpreting

Comprehension is a complex cognitive process that readers use to understand what they have read (Kintsch, W., 1998). Comprehension involves understanding vocabulary, background knowledge, text structure, and making inferences. Reading comprehension relies heavily on learning new content and vocabulary (Duke, N. K., & Pearson, P. D., 2009). Reading comprehension is the main goal of reading literacy. This requires the integration of phonemic awareness, decoding, and fluency, along with vocabulary and background knowledge, to build the meaning of the text. All of the basic reading skills ultimately serve the purpose of comprehension. If a learner can decode fluently but lacks comprehension, they have not yet achieved full reading literacy. Based on the deconstruction of the core components of reading literacy, it can be identified as a pattern of difficulty and possible need for intervention that can be carried out by teachers. Patterns of reading difficulties along with key characteristics and need for intervention. Comprehension is the main goal in reading activities, which refers to the reader's ability to understand, interpret, and evaluate information from the text. This process involves a complex interaction between cognitive skills, knowledge background, and metacognitive strategies. According to Snow (2002), reading without comprehension is nothing more than the pronunciation of written symbols, because meaning is not created only from words, but from the relationship of information in the text with the knowledge and experience that the reader has. Therefore, reading comprehension is a key indicator of the success of functional literacy (Psyridou et al., 2024).

Understanding the text does not happen automatically, but is the result of an active process that includes making predictions, drawing inferences, clarifying meaning, and summarizing information. These skills develop through continuous practice and the teaching of explicit reading strategies, such as reciprocal teaching, KWL (Know-Want to know-Learned), and think-aloud techniques (Duke & Pearson, 2002). This strategy allows students to be more aware of their thought process when reading, as well as develop reflective skills in composing the content of reading. In the context of primary school, strategy-based interventions are crucial given that children are still in the early stages of their cognitive development.

In addition to cognitive aspects, affective factors such as motivation, interest in reading, and attitude towards reading also have a great influence on comprehension. Guthrie and Wigfield (2000) emphasize that intrinsically motivated readers tend to have better understanding because they read with a more meaningful purpose and are oriented towards

the pursuit of knowledge. Therefore, a learning environment that supports curiosity, provides a wide variety of reading types that are relevant to students' interests, and provides space for discussion, is essential in forming deep and sustainable understanding. In today's digital era, reading comprehension also includes digital literacy and the ability to critically filter information from various sources(Ying & Su, 2024). Readers are required to understand not only print text, but also multimodal texts such as graphics, videos, and hyperlinks. This requires the development of critical reading and information literacy skills from an early age. Therefore, the approach to reading learning in elementary schools needs to be transformed by integrating digital texts, information analysis strategies, and collaborative-based activities to improve students' overall interpretation capacity. Patterns of Reading Difficulties and Need for Intervention Table 1 can be seen.

Table 1. Patterns of Reading Difficulties and Need for Intervention

Reading Difficulty Patterns	***Key Characteristics***	***Recommended Intervention Needs***
Decoding Difficulties	Struggles with phonemic awareness and letter-sound correspondence; reads words inaccurately and slowly; frequently misspells words	Explicit and systematic instruction in phonics and phonemic awareness; decoding exercises with decoded text; focus on building fluency at the word level
Weaknesses in Understanding	Reads words accurately but has difficulty understanding the meaning of the text; may have limited vocabulary; difficulty making inferences.	Targeted vocabulary development and concept instruction; teaching comprehension strategies such as prediction, clarification, and summarizing; Build background knowledge
Liquidity Deficit	Reads slowly and haltingly without expression; may struggle with decoding, which also affects fluency; does not automatically recognize common words.	Repeated reading exercises with instructional-level texts; guided oral reading with feedback; Strategies to Improve Word Recognition Automatically
Difficulty Reading Mixtures	Demonstrates weakness in decoding and comprehension; often has significant fluency difficulties	Comprehensive interventions that address all components of reading; explicit and systematic instruction in phonics and phonemic awareness; vocabulary development and comprehension strategies; fluency training

Based on the intervention framework in identifying reading difficulties above, to help educators make the right decisions about Artificial Intelligence (AI)-based reading platforms that are currently developing rapidly. Several tools that are the subject of reading intervention reviews can help implement the effectiveness of Deep Learning in improving Artificial Intelligence (AI)-based reading literacy. Examples of Artificial Intelligence (AI)-based reading tools and platforms can be seen in Table 2.

Tabel 2. CExamples of Artificial Intelligence (AI)-based reading tools and platforms

Platform	Main Feature	Target User
Amira Learning	AI-based one-on-one reading tutor, fluency assessment, personalized guidance	Students, Teachers
Project Read AI	Decodable text generator, question generator, phonics AI tutor	Students, Teachers
Spark Education AI	Generation of personalized stories, comprehension questions, progress tracking	Students, Teachers

Platform	Main Feature	Target User
Read Naturally	Fluency intervention program with text and audio recordings	Students, Teachers
Lexia Core5 Reading	Adaptive learning for basic reading skills	Students, Teachers
EPS Reading Assistant	Speech fluency assessment based on speech recognition, real-time intervention	Students, Teachers

Table 2. The above guidance on selecting and utilizing Artificial Intelligence (AI) platform resources and the implementation of Deep Learning learning methods, it is important to consider factors such as the technical expertise of the teacher and the development team, the specific requirements of the project, and the cost and scalability of the chosen resource. Best practices for data collection, preparation, and augmentation should be followed to ensure that Deep Learning models are trained on high-quality, representative data(Saryanto et al., 2023). When evaluating and selecting existing educational Artificial Intelligence (AI) tools, it is important to consider research evidence that supports their effectiveness, alignment with pedagogical goals, and ease of integration into the classroom(Hu et al., 2023). Factors such as cost, scalability, and level of technical support provided by vendors should also be taken into account when choosing an Artificial Intelligence (AI)-based literacy tool to improve reading skills for elementary school learners. Before implementing this learning method, it is hoped that further development will be complemented by the evaluation and early implementation of the Deep Learning learning method directly in elementary school students to measure its effectiveness empirically and further research the most relevant and effective Deep Learning architecture for natural language processing in the context of Indonesian reading learning (Garrison & Kanuka, 2004).

4. Conclusion

Based on the results of this study, it can be concluded that the development of deep learning-based learning methods has a significant positive impact on improving the reading skills of elementary school students. This approach not only improves decoding and word recognition skills, but also supports the development of reading fluency through the integration of adaptive technology that is able to provide personalized feedback in real-time. By leveraging artificial intelligence, students gain a more interactive, responsive, and appropriate reading experience for their level of cognitive development, thus facilitating the advancement of all-round reading skills, from phonemic awareness to text comprehension. Furthermore, the integration of deep learning in the reading learning process allows for the personalization of teaching strategies and systematic monitoring of student progress. This provides a great opportunity in addressing the gap in reading ability at an early age, especially for students with diverse learning needs. Therefore, this study recommends the application of deep learning-based learning models in elementary school literacy curriculum as a pedagogical innovation that can accelerate the achievement of reading competency standards and strengthen the literacy foundation that is essential for long-term learning success.

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