INTEGRATING DEEP LEARNING IN LANGUAGE LEARNING: INSIGHT FROM THE LITERATURE

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ABSTRACT

Deep Learning in language learning has the potential to revolutionize learning with its ability to process complex data. This study aims to: (1) identify key trends in the use of deep learning, (2) explore the benefits and challenges of implementing deep learning in language learning, and (3) determine future research directions based on gaps found in the literature. This study uses a literature review approach. The study's findings indicate a notable trend in the application of deep learning to a number of language learning domains, including online learning, sign language recognition, translation, language assessment, and personalized learning. Numerous advantages of deep learning were also noted by the study, including better learning outcomes, higher student engagement, and the creation of creative applications. The study did identify several difficulties, though, including the requirement for a huge amount of data, infrastructure constraints, and data privacy concerns. The researchers suggest that further research address the various gaps and maximize the potential of DL applications in learning.

Keywords: *deep learning, language learning, literature review*

INTRODUCTION

Significant developments in artificial intelligence have rapidly evolved various fields, one of which is education (Arbi, 2024; Widodo et al., 2024, 2025). One of the latest AI technologies is deep learning (DL), which has emerged as an essential tool in enhancing the language learning experience. Deep learning models, such as neural networks, have shown remarkable capabilities in understanding and processing complex language data. This creates a personalized and adaptive learning environment (Raup et al., 2022). However, the integration of deep learning into language education presents unique challenges and opportunities that require further exploration (Syarifudin, 2023).

Language acquisition remains a complex and dynamic process (Hafi et al., 2024), which requires continuous innovation to meet diverse learning needs. While traditional methods of language teaching have proven effective to some extent, they often fail to accommodate the pace and learning style of individuals. Deep learning offers a promising solution, but its application in language education is still in its infancy (Prasetyo & Dewayanto, 2024). Key challenges include understanding the practical implications, scalability, and pedagogical

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adjustments needed to maximize its potential. These issues highlight the need for a deeper investigation into the application and impact of deep learning in language learning contexts

While many existing reviews have explored the use of artificial intelligence (AI) in education, few have specifically focused on deep learning applications within language education contexts. Although previous studies acknowledge the potential of deep learning in language education (J. Shi, 2022; Z. Shi & Yang, 2024; Xu et al., 2022), most of them examine isolated applications, such as speech recognition, automated translation, or writing assessment, without addressing the broader pedagogical implications. Moreover, limited evidence exists on how deep learning can enhance collaborative, interactive, and communicative aspects of language learning. Therefore, this review aims to fill this specific gap by providing a focused synthesis of how deep learning has been applied in language education, highlighting its pedagogical potentials, challenges, and directions for future research. In particular, this study aims to:

1) identify key trends in the use of deep learning.
2) explore the benefits and challenges of implementing deep learning in language learning
3) determine future research directions based on gaps found in the literature.

Concept of Deep Learning

Deep learning can be considered as one of the subfields of artificial intelligence. It draws inspiration from how the human brain works. It works by using artificial neural networks to learn complex patterns in data. In practice, one can take advantage of this technology's ability to process large data to process natural language, recognize images, and recognize sounds. Deep learning, broadly speaking, allows computer devices to learn data without needing to be explicitly programmed for each task. Deep learning can be classified into 2 categories named Unsupervised Learning and Hybrid Deep Network (Raup et al., 2022). When a higher correlation value needs to be computed from the observed units in order to evaluate the pattern, and the target variable's label is unavailable, unsupervised learning is employed. The goal of a hybrid deep network is to perform pattern analysis using either supervised or unsupervised learning in order to produce good results. Referring to how deep learning is applied in everyday life, this technology is used in object recognition, biometric facial recognition, autonomous cars, virtual assistants, language translation tools, and chatbots (Naf'an et al., 2022).

In the context of language learning, deep learning becomes one factor that initiates learning transformation. This can happen because deep learning has been proven to facilitate learning to be more personal, effective, and enhance the learning experience. This theory can be proven by the results of previous studies that mention several key aspects, namely: (1) deep learning is capable of supporting personalized learning experiences (Kochmar et al., 2022; Sayed et al., 2023), (2) deep learning serves learner-generated context (Lee et al., 2023), and (3) deep learning can increase student independence (Kontesa et al., 2023). With its potential for contextual experiences, individualized learning, and greater student autonomy, deep learning essentially emerges as a key technology propelling revolutionary breakthroughs in language education.

In education, the difference between machine learning and deep learning is how they learn from data. Machine learning still needs human help to choose what information is important, while deep learning can find and learn patterns on its own using neural networks. Due to this, deep learning can handle more complex data types, such as text, sound, and images, making it useful for tasks like language learning, personalized feedback, and smart tutoring systems.

RESEARCH METHOD

The researchers used the literature review approach to get research findings about the adoption of deep learning in language learning. By using this method, the researchers were able to pinpoint important patterns,

investigate advantages and difficulties, compile their findings, and decide on future lines of inquiry on the use of deep learning in language learning. In order to produce a thorough understanding, the research design of this work was to review and analyze pertinent literature on the application of deep learning in the context of language acquisition.

The data source for this research is credible academic literature. The literature search was conducted through several databases, including Google Scholar, Sinta, and ResearchGate. The literature consists of various types, including journal articles, conference proceedings, theses or dissertations, books, and other quality and reliable online publications. The literature was collected by researchers by applying several keywords such as "deep learning in language learning", "AI in language learning", "effectiveness of deep learning in language learning", and so on.

To ensure relevance and quality, the researchers applied several inclusion and exclusion criteria. The inclusion criteria included: (1) studies published between 2015 and 2025, (2) articles written in English or Indonesian, (3) publications that are peer-reviewed, and (4) studies that explicitly discuss the application or impact of deep learning in language learning. Studies that were unrelated to education or lacked a direct discussion of deep learning in language learning. Studies that were unrelated to education or lacked a direct discussion of deep learning were excluded. After the screening and selection process, 20 studies that met all criteria were analyzed qualitatively using thematic analysis.

The collected data were then analyzed qualitatively. The researchers adopted thematic analysis in order to provide extensive findings. The analysis was carried out with the aim of: (1) identifying key trends in the use of deep learning, (2) exploring the benefits and challenges of implementing deep learning in language learning, and (3) determining future research directions based on gaps found in the literature.

FINDINGS AND DISCUSSION

Findings

Answering the objectives of this study, the researchers present research findings analyzed from several published literature in the form of research articles and conferences. The research findings are represented through tables. There are 3 tables that are adjusted to the objectives of the study. Based on the first research objective, namely identifying key trends in the use of deep learning, here is the first table:

Table 1. Key Trends in the Use of Deep Learning

No.	Authors	Findings
1.	(Raup et al., 2022)	*"Automatically, DL can represent data in the form of images, text, or videos without manual code rules or human knowledge. DL algorithms learn concepts with different levels of abstraction through Artificial Neural Networks (ANN)."*
2.	(Raup et al., 2022)	*"NVIDIA GPUs and Google Brain have been leveraging deep neural network technology to train high-performance deep learning since 2009."*
3.	(Raup et al., 2022)	*"The presence of DL in education can transform the curriculum."*
4.	(Rosalina & Sen, 2022)	*"It has been demonstrated that artificial neural networks can be utilized to develop AI applications that serve as learning aids for students, such as computers acting as virtual teachers or instructors."*
5.	(Yulianto & Iryani, 2024)	*"At different educational levels, DL techniques can produce more individualized, flexible, and data-driven learning experiences that improve students' comprehension and abilities."*

6.	(Anggraini & Zakaria, 2023)	*"With the use of convolutional neural networks (CNN), DL makes it possible to create interactive module learning applications that facilitate the provision of content by teachers and give students direct practice of it."*
7.	(Altiarika & Sari, 2023)	*"Deep learning through a combination of CNN+LSTM methods is used for hand prediction in Indonesian Sign Language (BISINDO), with a focus on filtering, layers, and objects."*
8.	(Z. Shi & Yang, 2024)	*"Through the use of Stacked Logistic Deep Learning (SLDL), deep learning is used in real-world English learning."*
9.	(Jiang, 2022)	*"The study proposes a four-dimensional model for DL in the context of learning, namely motivation, engagement, strategy, and direction competence."*
10.	(Amri, 2024)	*"Application of Convolutional Neural Network (CNN) algorithm with YOLOV5 to translate Indonesian sign language (BISINDO) to text."*
11.	(Xu et al., 2022)	*"Online English learning systems use DL to deliver individualized learning materials using data mining methods like association rules and cluster mining."*
12.	(J. Shi, 2022)	*"DL technology adoption to enhance educational evaluation quality, particularly in the context of English instruction. an assessment system that is more precise, data-driven, and neural network algorithm-based."*

Referring to the second research objective, which aims to analyze the benefits and challenges of implementing deep learning in language learning, the researcher presents the data by classifying the findings in the form of a table. The table contains research aspects, data numbers, author names, and year of publication, and a synthesis of findings from previous research.

Table 2. Benefits and Challenges of Implementing Deep Learning in Language Learning

No.	Research Aspects	Author	Findings
1.	Benefits of DL	(Raup et al., 2022)	*"DL in Language translator makes it easier for users to learn human voice and language."*
2.	Challenges	(Raup et al., 2022)	*"DL requires large data to support DL model training."*
3.	Benefits of DL	(Rosalina & Sen, 2022)	*"DL can be adopted as an effective learning partner."*
4.	Benefits of DL	(Yulianto & Iryani, 2024)	*"DL can improve student engagement and learning outcomes through personalized learning. DL also allows for faster and more detailed feedback."*
5.	Challenges of DL	(Yulianto & Iryani, 2024)	*"The main challenges of using DL in language learning are infrastructure limitations, teacher training, and issues related to user data privacy and security."*
6.	Challenges of DL	(Yulianto & Iryani, 2024)	*"Limited technological readiness is a major barrier to integrating DL into the curriculum."*
7.	Benefits of DL	(Altiarika & Sari, 2023)	*"The significance of this study lies in its potential to accelerate the development of sign language recognition applications, specifically for BISINDO, which the community and individuals with disabilities can use to facilitate real-time two-way communication in the future."*
8.	Benefits of DL	(Z. Shi & Yang, 2024)	*"Through useful techniques based on SLDL, the usage of DL can improve the efficacy of teaching English. DL has also been shown to raise pupils' average English proficiency by as much as 20%."*

9.	Benefits of DL	(Z. Shi & Yang, 2024)	*"DL helps students learn English by facilitating experiences that are customized to meet their needs. Additionally, DL improves language learning and retention."*
10.	Benefits of DL	(Jiang, 2022)	*"In language learning, the four-dimensional deep learning approach improves both theoretical comprehension and empirical application."*
11.	Benefits of DL	(Jiang, 2022)	*"High motivation scores but low direction competence is seen in surveys."*
12.	Benefits of DL	(Jiang, 2022)	*"DL offers a standardized tool for future studies on deep learning in language education."*
13.	Challenge of DL	(Jiang, 2022)	*"Student engagement is relatively low despite differences in their English levels and vision. Directional competence is low across educational levels and EFL course groups."*
14.	Benefits of DL	(Amri, 2024)	*"In the process of translating sign language, YOLOV5 effectively and accurately recognizes and classifies objects. This promotes communication and inclusivity between the deaf population and those who are unable to utilize sign language."*
15.	Challenge of DL	(Amri, 2024)	*"Because Sign Language signs are complex, using CNN with YOLOV5 to translate them requires a high-quality dataset to increase accuracy."*
16.	Benefits of DL	(Xu et al., 2022)	*"Genetic algorithm-based learning systems can provide adaptive and personalized learning content."*
17.	Benefits of DL	(Xu et al., 2022)	*"Collaborative learning can be organized based on the results of cluster mining of learner profiles."*
18.	Challenge of DL	(Xu et al., 2022)	*"Online learning models require consistent adaptive updates from the teaching model."*
19.	Challenges of DL	(J. Shi, 2022)	*"To adopt DL in educational evaluation, one needs very sophisticated hardware and takes a long time, and there are still errors."*
20.	Benefits of DL	(J. Shi, 2022)	*"DL-based evaluation methods offer great potential for improving the quality of English language teaching."*

Based on the third objective of this study, the researcher found several facts that are relevant to the topic of this study. These facts are related and relevant to Future Research Directions Based on Gaps Found in the Literature. The data are classified as presented in Table 3.

Table 3. Future Research Directions Based on Gaps Found in the Literature

No.	Author	Findings
1.	(Yulianto & Iryani, 2024)	*"Further research is needed to evaluate the impact of DL on student learning outcomes at different levels of education."*
2.	(Yulianto & Iryani, 2024)	*"Future research needs to expand the focus on students' psychological and social aspects resulting from the adoption of DL technology in learning."*
3.	(Yulianto & Iryani, 2024)	*"Research needs to consider several contexts, namely social, cultural, and economic (local and global). This aims to make DL more relevant and inclusive."*
4.	(Jiang, 2022)	*"Further research can use standardized instruments developed to explore deep learning in language education."*

5.	(Jiang, 2022)	*"More effective instructional strategies need to be developed to enhance student engagement in deep learning."*
6.	(Amri, 2024)	*"The CNN system might be improved in future studies to recognize body language, facial expressions, and other components of sign language."*
7.	(Xu et al., 2022)	*"To enhance online learning, DL-based learning platforms are expected to be implemented in online learning platforms other than language learning. The use of knowledge migration to enhance the quality of online learning model adaptation can be investigated further in future studies.*
8.	(J. Shi, 2022)	*"Future studies are required to lower the overhead in the DL process, considering the context of applying DL for learning evaluation. Additionally, future studies ought to concentrate on time and hardware-efficient alternatives."*

Discussion

Key Trends in the Use of Deep Learning in Language Learning

Based on the findings of this study, the use of deep learning (DL) in various contexts shows significant progress in education, especially in the context of language education. DL has been shown to be able to represent data in various forms (image elements, text, or video) without the need for manual code rules or human knowledge, through learning concepts with various levels of abstraction using Artificial Neural Networks (ANN) (Raup et al., 2022). In everyday learning, DL not only supports more individual and data-based learning to improve students' understanding and abilities (Yulianto & Iryani, 2024), but also enables the development of interactive applications such as Convolutional Neural Networks (CNN)-based learning modules (Anggraini & Zakaria, 2023).

DL is used for more specialized purposes in addition to general ones, like translating Indonesian Sign Language (BISINDO) using CNN+LSTM (Altiarika & Sari, 2023) or CNN Algorithm with YOLOV5 (Amri, 2024). Additionally, an online learning system that uses data mining techniques to provide individualized learning materials uses DL to promote English language acquisition (Xu et al., 2022) All things considered, this technology holds huge potential for raising the standard of educational assessment (J. Shi, 2022) and even revolutionizing the curriculum (Raup et al., 2022). These results highlight how adaptable and effective DL is in fostering innovation in education.

Benefits and Challenges of Using Deep Learning in Language Learning

Viewing the data presented in Table 2, the implementation of deep learning (DL) in language learning shows significant benefits and various challenges. One of the key benefits of DL is its ability to make it easier for users to understand human speech and language through language translator tools (Raup et al., 2022) DL can also improve student engagement and learning outcomes through a personalized learning approach, as well as providing faster and more detailed feedback (Yulianto & Iryani, 2024) In addition, DL has the potential to develop real-time sign language recognition applications that support inclusive communication for people with disabilities (Altiarika & Sari, 2023; Amri, 2024). In the context of English language learning, DL has been shown to improve students' average ability by up to 20% through an approach tailored to their needs (Z. Shi & Yang, 2024) The four-dimensional approach of DL also improves theoretical understanding and empirical application in language learning (Jiang, 2022). Furthermore, DL provides an adaptive and collaborative genetic algorithm-based system for personalized learning content (Xu et al., 2022). On the other hand, DL-based evaluation methods have great potential to improve the quality of English language teaching (J. Shi, 2022)

However, the challenges of implementing DL in language learning cannot be ignored. The main challenges are the need for large data to train DL models (Raup et al., 2022) as well as limited infrastructure, teacher training, and user data privacy (Yulianto & Iryani, 2024). In addition, limited technological readiness is also an obstacle in

integrating DL into the curriculum (Yulianto & Iryani, 2024) The need for very sophisticated hardware, long processing time, and the risk of errors in adopting DL for educational evaluation are also major obstacles (J. Shi, 2022) The use of CNN with YOLOV5 in sign language translation requires high-quality datasets to improve accuracy (Amri, 2024) and online learning models require consistent adaptive updates (Xu et al., 2022). Overall, although DL offers great benefits in language learning, its success is highly dependent on technological readiness, infrastructure support, and strategies to overcome existing challenges.

Future Research Directions Based on Gaps Found in the Literature

As shown on Table 3, there are various future research opportunities related to the implementation of deep learning (DL) in language learning. One of the main focuses is to evaluate the impact of DL on student learning outcomes at various levels of education and to expand attention to the psychological and social aspects of students arising from the use of this technology (Yulianto & Iryani, 2024). In addition, research needs to consider the social, cultural, and economic contexts to make DL more relevant and inclusive locally and globally (Yulianto & Iryani, 2024). Future research can also develop standard instruments to explore DL in language education and more effective strategies to increase student engagement (Jiang, 2022).

In addition, it is necessary to develop a CNN system to recognize body language and facial expressions in sign language (Amri, 2024). The study of DL-based online learning platforms also needs to be expanded beyond language learning, with a focus on improving model adaptation through knowledge migration (Xu et al., 2022). Finally, research can explore ways to reduce the computational burden of DL to be more efficient in time and hardware (J. Shi, 2022). Context concerns, teaching methods, and the creation of more inclusive technology are all potential areas for future research that should improve the applicability and efficacy of DL implementation in language learning.

From a pedagogical perspective, the integration of deep learning in language education can also be connected to several established learning theories. For example, it aligns with constructivism, as learners actively build their own knowledge through interaction with intelligent systems that adapt to their needs. It also reflects the principles of connectivism, where learning occurs through networks of people and digital tools that continuously exchange information. Moreover, deep learning supports the goals of Computer-Assisted Language Learning (CALL) by enabling more interactive, data-driven, and personalized language learning experiences.

Theoretical and Practical Implications

Theoretically, the results of this study provide a positive contribution and enrich the existing literature, especially on how deep learning is adopted in language learning. The findings of this study confirm the great potential of deep learning in transforming language education because this technology has been proven to create a positive learning environment, especially in terms of learning personalization and learning efficiency. The results of this study can also be used as a basis for developing more flexible, creative, and interactive learning models by integrating deep learning technology. In addition, this study also provides insight into the positive role of deep learning in learning evaluation.

Viewed from a practical implication, the results of this study reveal that DL allows the development of learning systems that are tailored to the requests and needs of students. This directly increases the effectiveness of learning, especially language education. The results of this study also have implications for improving skills where students are assisted in improving language skills such as comprehension, interaction, and production. This study has also been shown to encourage the development of tools or technologies that can assist language learning. For example, we can develop adaptive learning platforms and accurate language identification tools.

Strengths and Weaknesses of this Research

This research has several strengths and weaknesses. The main strength lies in its relevance to current technological developments and educational needs, highlighting how deep learning can transform language education. It also covers a wide range of aspects, from benefits to challenges, offering a comprehensive perspective on the role of deep learning in language learning. Another strength is its multidisciplinary nature, combining insights from education, linguistics, and computer science. However, this study also has several limitations. The scope of the review is limited to English-language and Indonesian-language studies, which may exclude relevant works published in other languages. In addition, the methodological approach focuses solely on qualitative thematic analysis without including a quantitative synthesis such as meta-analysis, which could provide stronger statistical validation of the findings. The selection of databases and keywords may also limit the comprehensiveness of the reviewed literature. To improve future research, several strategies are suggested. Researchers can expand the scope by including studies in other major languages and applying mixed-method approaches, combining qualitative synthesis with quantitative data analysis. Furthermore, triangulating findings with practitioner interviews, classroom observations, or case studies could provide richer insights and validate the theoretical conclusions with real-world practices. These efforts will strengthen the reliability, validity, and practical impact of future studies on deep learning in language education

CONCLUSION

This study uses a literature review method in order to analyze the implementation of deep learning in language learning. The results of the study show a significant trend in the use of deep learning in various aspects of language learning, such as translation, sign language recognition, online learning, language evaluation, and personalized learning. The study also identified various benefits of deep learning, such as increased student engagement, improved learning outcomes, and the development of innovative applications. However, the study also found several challenges, such as the need for large data, infrastructure limitations, and data privacy issues.

Several recommendations can be made in light of the study's findings. In order to fully comprehend the long-term effects of deep learning deployment on many facets of learning a language, more research is first required. Second, to accommodate a range of learning requirements, it is imperative to continuously construct deep learning models that are more personalized and adaptive. Third, by providing educators with training and building suitable infrastructure, efforts must be made to improve accessibility and equity in the application of deep learning. Lastly, it is important to consider the ethical implications of deep learning, which is why interdisciplinary cooperation is required to guarantee that the use of this technology yields the greatest possible advantages for all stakeholders.

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