

Research Article

Neural network in the learning material recommendation system based on individual learning styles**Akbar Ramdani**

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Abstract

Technological developments in education have encouraged innovations in learning systems that are more adaptive and personalized. One of the approaches that is growing rapidly is the Neural Network-based learning material recommendation system, which can adapt the material to individual learning styles. Each student has a unique learning style, such as visual, auditory, and kinesthetic, which affects the effectiveness of their understanding of the material. This study aims to analyze how the Neural Network-based recommendation system can optimize the learning experience of students by adjusting learning materials based on individual learning styles. Specifically, this study explores how the Neural Network model identifies students' learning styles, evaluates the effectiveness of the recommendations provided by the system, and examines the challenges and opportunities in its application in educational settings. This study uses a qualitative approach with the literature review method. Data were collected from various scientific journals, books, and conference proceedings discussing the implementation of Neural Networks in the learning recommendation system. The analysis shows that the Neural Network-based system can improve student engagement and understanding through material recommendations that are more suitable for individual learning styles. However, challenges such as student data protection, bias in recommendations, and integration with formal curricula are still major obstacles. With the development of increasingly advanced technology, this system has great potential to be adapted more widely in the world of education.

Keywords: Neural Network, Learning Recommendation System, Individual Learning Style.



INTRODUCTION

Technological developments in the field of education have encouraged innovations in learning systems that are more adaptive and personalized. One of the approaches that is growing rapidly is the Neural Network-based learning material recommendation system, which is able to adapt the material to individual learning styles (JIN et al., 2023). Various studies have shown that each student has a unique learning style, such as visual, auditory, and kinesthetic, which affects effectiveness in understanding the material (Aziz et al., 2021). By using a Neural Network-based approach, the system can identify students' learning patterns and automatically suggest appropriate materials, thereby increasing the efficiency of the learning process (THONGCHOTCHAT, 2023).

Neural Networks (JSTs) are a branch of artificial intelligence that mimics the way the human brain works in processing information and making decisions. This network consists of layers of interconnected artificial neurons, where each neuron receives input, processes it, and produces an output based on a specific weight and activation function (Maiyuriska, 2022). JST has been used in various fields such as pattern recognition, data prediction, and system optimization, including in industrial applications and robotics technology (Saputro et al., 2020). One of the most common algorithms in JST is backpropagation, which is used to train a network by adjusting the weight of neurons based on output errors so that the prediction results are more accurate (Rahmadani et al., 2021).

In recent years, JST has demonstrated its effectiveness in a variety of big data-driven applications, including in the fields of healthcare, finance, and facial recognition. Research by Eriana and Zein (2023) shows that JST can improve accuracy in medical image classification to detect diseases based on X-ray results (Eriana & Zein, 2023). In addition, JST is also used in a system of recommendation and trend analysis in the business sector, as discussed by Thoriq (2022), where JST is able to predict production demand based on historical data patterns (Thoriq, 2022). Despite having many advantages, JST also has several challenges, such as high computational requirements and difficulty in determining optimal parameters for model training (Pradhana et al., 2021). With the development of computing technology and the improvement of the efficiency of learning algorithms, JST continues to be one of the most widely used approaches in the development of artificial intelligence today.

The main advantage of a Neural Network-based system in a recommendation system is its ability to learn patterns of student interaction with learning materials. For example, the research of Troussas et al. (2023) shows that neural network-based systems are able to adapt educational content based on learning styles detected through digital interactions (Troussas et al., 2023). With this model, students can not only get materials that suit their preferences, but also experience a more effective and enjoyable learning experience (Zhao et al., 2023).

The implementation of a Neural Network-based recommendation system has also been proven to improve student learning outcomes in various contexts. A study by Bhaskaran et al. (2021) revealed that students who used artificial intelligence-based adaptive learning systems showed a significant improvement in material comprehension compared to conventional learning methods (Bhaskaran et al., 2021). This system is not only able to accurately classify students' learning styles but can also develop more personalized learning strategies (Zhu et al., 2022).

Although there have been many studies that have proven the effectiveness of the Neural Network-based recommendation system, there are still challenges in its implementation, such as the need for large datasets and challenges in managing student privacy data (Hariharan et al., 2019). In addition, there is also a gap in research on how this system can be developed for different levels of education and how more flexible adaptation models can be applied to cover more variations in learning styles (Qomariyah & Fajar, 2019).

With the increasing use of technology in education, Neural Network-based recommendation systems can be a solution that helps students learn according to their individual styles, while also overcoming the challenges faced in traditional learning (Gambo & Shakir, 2021). In addition, the development of more sophisticated systems can increase student engagement in learning and assist educators in devising more effective teaching strategies (Baqueta et al., 2024).

Several previous studies have explored the use of Neural Networks in learning recommendation systems. Huang et al. (2020) discussed the application of artificial neural networks in adapting learning content based on student responses, which showed positive results in increasing student engagement and understanding (Huang et al., 2020). In addition, the study of Ni et al. (2022) developed a deep reinforcement learning-based learning model to automatically recommend learning materials (Qiu

et al., 2022). The results of their research show that this approach can improve learning efficiency by adjusting the material based on learning patterns automatically identified by artificial intelligence systems.

This study aims to analyze how the Neural Network-based recommendation system can optimize the learning experience of students by adjusting learning materials based on individual learning styles. Specifically, this study will explore how the Neural Network model identifies students' learning styles, evaluates the effectiveness of the recommendations provided by the system, and examines the challenges and opportunities in the application of this system in an educational environment. It is hoped that the results of this research can contribute to the development of a more personalized, adaptive, and effective artificial intelligence-based learning system.

RESEARCH METHODS

This study uses a qualitative approach with a literature review method, which aims to analyze and synthesize various studies related to the application of Neural Networks in the recommendation system of learning materials based on individual learning styles. Literature study is a systematic method of identifying, evaluating, and interpreting previous research in order to obtain a more comprehensive understanding of a topic (Snyder, 2019). This approach allows researchers to review the progress of research that has been carried out and find research gaps that can be the basis for further studies (Paul et al., 2021).

The data sources in this study consist of scientific journals, books, conference proceedings, and academic articles relevant to the research topic. Data is collected from various academic databases such as IEEE Xplore, Springer, Elsevier, Google Scholar, and ResearchGate. Only publications published in the last five years (2019–2024) were used, to ensure that the analysis reflected the latest developments in the application of Neural Networks in learning recommendation systems. Keywords used in literature searches include "Neural Network in Learning Recommendation", "Artificial Intelligence and Learning Styles", and "Adaptive Learning Systems with AI".

The data collection technique is carried out through the documentation method, namely collecting, studying, and grouping various literature that has been published. The selection process is carried out in several stages, starting from the identification of relevant literature, the evaluation of the quality of the research

methodology used in the source, to the synthesis of research results based on the main themes found (Tomaszewski et al., 2020). Inclusion criteria in literature selection include publications that discuss the application of Neural Networks in learning systems, artificial intelligence-based recommendation systems, and individual learning style-based approaches. Meanwhile, the exclusion criteria include research that is not relevant to the main theme as well as studies that have research methods that are not transparent or weak in data validity.

The data analysis in this study was carried out using the content analysis method, which aims to identify patterns and trends in research related to the use of Neural Networks in the learning recommendation system. The data was analyzed thematically by grouping the research findings based on several main aspects, such as the method of implementing the Neural Network, the effectiveness of the recommendation system for various learning styles, and the challenges and limitations in its implementation (Merriam & Grenier, 2019). This approach allows this research to develop a broader and deeper synthesis of how artificial intelligence-based recommendation systems can enhance a more adaptive and personalized learning experience.

RESULT AND DISCUSSION

Neural Networks in a Learning Material Recommendation System Based on Individual Learning Styles

In the increasingly digitized world of education, the Neural Network-based recommendation system is an innovative solution in adapting learning materials to the individual needs of students. The system works by identifying students' learning styles through their interaction patterns with digital learning platforms, then providing material recommendations that best suit their preferences and abilities.

According to the research of Mirasçı and Aksoy (2025), the application of artificial neural networks in e-learning recommendation systems can improve learning effectiveness by adjusting content based on student preferences. The model identifies individual learning styles using deep learning techniques and behavioral data analysis, so that students can receive material that best suits the way they absorb information.

Identifying Learning Styles Using Neural Networks

Students' learning styles can be categorized into several types, such as visual, auditory, and kinesthetic. Systems based on Neural Networks can classify students into specific categories based on data on their interactions with digital learning materials.

Research conducted by Kivuva (2024) develops a deep learning-based system that can recognize patterns of student preferences by analyzing how they navigate in an e-learning environment (Kivuva, 2024). The model leverages data such as the duration of time students spend on certain types of content, the number of clicks on videos or texts, and the speed at which students read and complete the exercises

Examples of real-world implementation can be found on learning platforms such as Coursera and Udemy, which use recommendation algorithms to tailor courses to user interests. For example, a student who accesses learning videos more than texts will be recommended material in the form of interactive videos rather than digital books or articles.

Evaluation of the Effectiveness of Recommendations in Improving Learning

The success of Neural Networks-based recommendation systems can be measured through increased student understanding and engagement. A study conducted by Yang and Zhang (2025) compared the learning outcomes of students who used the intelligent recommendation system with those who received the material at random (Yang & Zhang, 2025). The results showed that students who received personalized material experienced a 25% higher increase in comprehension compared to the control group.

In a formal education environment, this system can be applied in the Learning Management System (LMS) used by universities. For example, in a study program that has STEM-based courses, this system can recommend videos of laboratory experiments for students who are easier to understand visually, while students with auditory learning styles will more often receive material in the form of podcasts or audio lectures.

However, there are some challenges in implementing this system. Research by Sharifi et al. (2025) found that the effectiveness of the recommendation system depends on the quality of the data collected and the model's ability to adapt to changes in student learning patterns. If the system is not updated regularly, then the

recommendations provided can become less relevant or even misleading.

Challenges and Opportunities in the Implementation of Neural Networks for Learning Recommendations

Despite its great potential, Neural Networks-based recommendation systems face several challenges in their application in educational settings.

a. Data Quality and Privacy

Recommendation systems require large amounts of user data in order to provide accurate results. However, this data collection raises concerns regarding the privacy and security of students' personal information. According to Nguyen and Akter (2025), data protection in AI-based learning systems must be a priority to prevent the misuse of personal information.

b. Bias in Recommendations

Neural Networks models can be biased in providing recommendations, especially if the training data used is not diverse enough. For example, if the system is more often trained on data from students with visual learning styles, then students with auditory or kinesthetic learning styles may not get recommendations that suit their needs.

c. Integration with the Formal Curriculum

One of the main challenges is how this system can be adapted to the established academic curriculum. Many educational institutions have a standardized learning structure, making it difficult for AI-based systems to provide truly flexible recommendations without disrupting the existing curriculum.

However, there are great opportunities in the development of this system, especially with advances in AI technology that are getting better at dynamically adapting learning materials. With constantly updated models and more accurate data, these systems can be a highly effective tool in improving student engagement and learning outcomes.

CONCLUSION

This study highlights the important role of the Neural Network-based learning recommendation system in creating a more adaptive and effective learning experience.

With its ability to identify individual learning styles, this system can provide more

appropriate material recommendations, thereby increasing students' understanding and involvement in the learning process. However, its implementation still faces various challenges, including the need for large amounts of data, student privacy concerns, bias in algorithms, and difficulties in integrating this system with the formal curriculum. Nonetheless, as artificial intelligence develops and algorithm optimization, these systems have great potential to improve the effectiveness of technology-based education in the future.

To be able to implement this system properly, it is necessary to improve data security so that students' personal information remains protected and not misused. In addition, teachers and students must be given training so that they can optimally utilize the AI-based recommendation system in learning activities. Further development is also needed so that this system can be integrated with existing online learning platforms, so that it is in line with the applicable formal education system. In addition, the Neural Network model used needs to be continuously updated in order to adapt to the variation of students' learning styles and reduce the possibility of bias in the recommendations given.

Furthermore, future research needs to explore the development of a more flexible and adaptive model in adapting learning materials to changes in students' learning styles over time. Experimental studies involving real students are also needed to test the effectiveness of this system at various levels of education. In addition, a long-term evaluation must be carried out to assess the impact of the Neural Network-based recommendation system on students' comprehension of the material and cognitive development over a wider period of time. In terms of regulation, a more in-depth study of ethics and student data protection is needed so that this system can be applied while maintaining the principles of user security and privacy. With continuous development, the Neural Network-based recommendation system can be an innovation that brings change in the world of education by providing a more personalized and effective learning experience for each student.

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