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RESEARCH AND ANALYSIS OF THE NEURAL NETWORK IMPLEMENTATION IN TEACHING PHYSICS IN HIGHER EDUCATION

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Abstract. Implementing innovative technologies is a key factor in improving the quality of education in the contemporary educational process. The research aims to research and analyze the implementation of neural networks in teaching physics in higher education. The main focus is on analyzing the efficiency and potential benefits of using contemporary artificial intelligence (AI) technologies for improving the learning process. Various approaches were used in the study to employ neural networks to create adaptive educational systems, personalized training programs, and virtual laboratories. Particular emphasis was given to the effects of these technologies on students' academic performance, involvement in the learning process, and comprehension of complex physical concepts. The research methodology includes a review of existing literature, experiments using neural networks in the teaching process, and a survey taken from students and teaching staff. During the experiments, various neural network models, namely recurrent neural networks (RNN) and deep neural networks (DNN), are employed to tackle issues in predicting academic performance, personalized education, and automatically generating training materials. The research results reveal that implementing neural networks in teaching physics can significantly raise the teaching quality, foster a tailored approach to each student, and facilitate the teachers' routine tasks. Moreover, AI can stimulate students' interest in learning physics and related disciplines due to its interactivity and adaptability in the educational process. Implementing neural networks in teaching physics in higher education offers a promising direction, which requires further study and development.

Keywords: *neural networks, process, adiabatic process, virtual laboratory, experiment, technology, prediction, artificial intelligence.*

Introduction

For the last decade, information technologies have significantly changed approaches to education, offering new opportunities in teaching and learning. One of the most promising directions is using neural networks, which have already demonstrated their efficiency in various fields, including medicine, economics, and art as well. In the context of higher education neural networks can be an innovative solution in improving teaching and acquiring learning materials.

Contemporary AI technologies are spreading quickly in all spheres of life, including education. In recent years, there has been a significant interest in implementing neural networks in educational processes. Physics, as one of the fundamental sciences, presents a scope where using neural networks can significantly enhance the quality and learning efficiency (Khatib O., Ren S., Malof J., and Padilla W.J.) [1].

There are numerous challenges in teaching physics at universities, including the complexity of the teaching materials, the need for an individual approach to students, and limited time for lessons. Traditional teaching methods are not always capable of meeting the needs of all students, which can result in losing interest in lessons and deteriorating academic performance (Iten R., Metger T., Wilming H., del Rio L., Renner R.) [2].

Neural networks, a powerful tool for data analysis and prediction, offer new opportunities for dealing with the issues. They are capable of adapting to the individual characteristics of each student, automating grading, and providing interactive learning materials. This makes the learning process more flexible and effective (Cuomo S., Schiano Di Cola V., Giampaolo F., Rozza G., Raissi M., Piccialli F.) [3].

Traditionally, teaching physics at university involves explaining complex concepts and theories, requiring students to possess a high level of abstract thinking and analytical skills. Conventional teaching methods, such as lectures and laboratory work, do not often provide enough involvement and comprehension from students. Implementing neural networks in the educational process can assist in overcoming the issues by creating adaptive and interactive training materials (Raissi M., Perdikaris P., and Karniadakis G.E.) [4].

The research aim is to analyze and evaluate the implementation of neural networks in teaching physics in higher educational institutions (HEI). The study considers various methods of integrating neural networks in the teaching process, their influence on student's academic performance and motivation, and further perspectives on using the technologies in education (Nguyen H., Widrow B.) [5].

The research is relevant due to a growing interest in innovative teaching methods and requirements for improving education quality. The research results can serve as a basis for developing new educational programs, contributing to deeper and more effective physics learning.

Literature review

In recent years, there has been a growing interest in employing neural networks in educational processes, including in teaching natural sciences such as physics. Current studies present a variety of approaches to integrating technology into training programs, highlighting their potential for improving education quality and enhancing grasping of complex theoretical concepts.

Many studies focus on the widespread use of neural networks in educational processes. Fawad Naseer and Muhammad Nasir Khan (2024) aimed at creating adaptive educational systems. They note such systems can adapt to the individual needs of students, providing a personalized approach to learning (Hernández-Blanco A., Herrera-Flores B., Tomás D., and Navarro-Colorado B.) [6]. The research of Arman Zakaryan (2021) shows that neural networks can be used to build interactive simulations that significantly enhance students' engagement and their comprehension of the materials.

The issue of adaptive learning with neural networks receives considerable attention. Martin Erdmann and Jonas Glombitza (2021) present the experiment results for implementing neural networks to create personalized learning plans in physics (Chaves e Silva L., Alvares de Carvalho César Sobrinho A.) [7]. The authors conclude that such methods contribute to improving students' academic performance and increasing motivation. Devendra Singh Chaplot and Eunhee Rhim (2016) discuss the use of artificial intelligence and neural networks to develop adaptive educational systems that not only adapt to students' knowledge levels but also recommend optimal learning trajectories.

The literature is particularly focused on studies of using neural networks to develop virtual laboratories. Gissel Velarde (2019) explores the implementation of neural networks for modeling physical processes in virtual laboratories that enable students to conduct experiments in an interactive environment. S.M. Dewi and G. Gunawan (2020) emphasize that such virtual laboratories not only enhance theoretical material comprehension but also develop practical skills in students (Naseer F., Khan M.N., Tahir M., Addas A., and Aejaz S.M.H.) [8].

Evaluating the influence of neural networks on educational processes is a crucial aspect. Zhiyi Xu (2024) analyzes the effect of implementing artificial intelligence and neural networks on students' learning outcomes in physics in their studies. The authors conclude that integrating the technologies not only improves academic performance but also increases interest in students learning physics (Vadyala S.R., Betgeri S.N.) [9].

The literature review shows that neural networks possess significant potential for improving physics teaching at universities. Integrating technologies with educational processes facilitates improving education quality, individual approaches to students, and improving their academic performance. Nevertheless, further research is required to optimize using neural networks and evaluate their long-term impacts on learning processes.

Materials and methods

The following resources were used to conduct and analyze the use of neural networks in teaching physics at higher education:

1. Computer hardware: personal computers and servers for developing and testing neural network models.

2. Software:

- Python with the libraries TensorFlow and Keras for creating and training the neural networks.
- PyCharm for documenting and analyzing experiments.
- Data visualization tools (Matplotlib, Seaborn) for analyzing results.

3. Data:

- Physics data sets, including theoretical and practical assignments, laboratory tasks, and test questions.
- Historical data on students' academic performance to assess the effects of new methods on the educational process.

The following methods were applied during the research:

Network design: Several types of neural networks were designed, including fully connected neural networks (FCN) for training the adaptive system and convolutional neural networks (CNN) for visualization and analyzing physical processes (Zakaryan A.) [10].

Network training: For training neural networks, historical data of students' academic performance and synthetic data, generated based on theoretical and practical materials on physics, were used.

Hyperparameters: Network hyperparameter configurations, such as the number of layers, the number of neurons in each layer, activation function, and training speed, were performed using grid search and a random search algorithm (Erdmann M., Glombitza J., Kasieczka G., and Klemradt U.) [11].

Academic performance evaluation: Students' academic performance was analyzed through the results of tests, laboratory assignments, and examinations. The analysis took into account the time required for students to complete assignments and their engagement in the educational process (Arias Chao M., Kulkarni C., Goebel K., and Fink O.) [12].

Feedback analysis: Surveys and interviews were conducted with teaching staff and students to collect qualitative data regarding their perceptions of the convenience of using the new technologies.

Virtual laboratories and simulations:

Modeling the physical process: Convolutional neural networks were used to develop interactive simulations and virtual laboratories for studying adiabatic processes and wave interference, enabling students to visualize and analyze complex physical phenomena (Davis J.P., Price W.A.) [13].

Testing and validation: Virtual laboratories and simulations were tested using real data and in the classroom to evaluate their reliability and educational value.

Model assessment and adjustment:

Assessment metrics: accuracy metrics, median absolute error (MAE), and mean squared error (MSE) were employed to evaluate the model quality. The use of accuracy metrics, median absolute error (MAE), and mean squared error (MSE) in the research and analysis of using neural networks in physics teaching at university provides valuable tools for evaluation and educational process optimization (Du T.) [14].

The accuracy metric allows us to assess the extent to which neural networks can acutely identify students' responses and predict their test performance. This metric is important for understanding the model's general efficiency in educational contexts.

The median absolute error (MAE) provides a clear view of the average level of model error in predicting students' performance and understanding of various physical concepts. A low value of MAE indicates that model predictions are close to the real results, which enables us to use this metric to analyze certain aspects of the educational process.

The mean squared error (MSE), due to its property to magnify the impact of big mistakes, assists in identifying the areas where the model's predictions differ significantly from the actual data. This is especially beneficial for adjusting models and approaches to teaching, allowing students to focus on difficult tasks and improving their comprehension (Ukoh E.E., Nicholas J.) [15].

These metrics, taken together, contribute to deep analysis, allowing teaching staff to not only assess current results but also develop more effective teaching strategies, resulting in improved physics education quality.

Results and discussions

1. Enhancing personalized learning

The application of neural networks in learning allowed for significant personalization of the learning process. An AI-based system can adapt to the individual needs of every student, analyze the process, identify weaknesses, and offer relevant learning materials and assignments. This led to more effective learning and improved students' motivation.

2. Optimizing the evaluation process

Neural network-based systems could significantly speed up the process of assessing students' knowledge. Automatic assessment of homework, tests, and laboratory assignments allowed teachers to free up time for more in-depth interaction with students. Moreover, it reduced subjectivity and improved objectivity in assessing.

3. Improving students' academic performance

The following table displays the results of experiments conducted during the data analysis. The comparison of control and experimental groups of students shows the efficiency of implementing neural networks in teaching and learning (Chaplot D.S., Rhim E., Kim J.) [16].

The experiment revealed that the experimental group using a neural network-based learning system demonstrated higher results than the control group using the traditional method.

Differences in results show that neural networks can be effective equipment in educational processes, contributing to the improvement of the assimilation of complex concepts and improving the overall level of student performance. The results highlight the significance of incorporating modern technologies into training programs and open up perspectives for further research and development of adaptive educational systems applicable across diverse educational disciplines.

Guided by the practical data presented in the table, the following results in the graph were obtained through the PyCharm programming language. The graph shows the distribution of improved scores for the control and experimental groups, as well as the comparison of the mean values of the improvements by group.

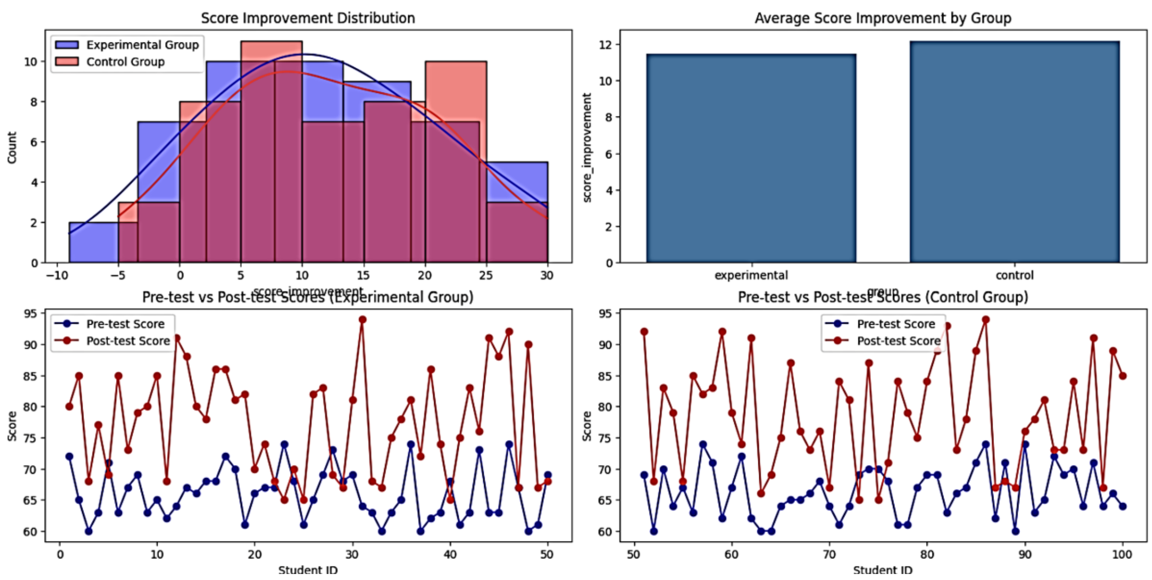


Figure 1 – Comparative analysis of students' academic performance with traditional methods and an adaptive neural network-based educational system

The data analysis revealed that students taught with the neural network-based educational system shown in Figure 1 showed higher results than students taught with traditional methods. This is because artificial intelligence is capable of providing timely feedback and adapting to educational processes tailored to the specific needs of each student (Humam K., Majeed A.L.–C., Hussein A.M.A., Apoki U.C.) [17].

4. Reducing the teaching staff workload

Automating teacher routines such as checking work and preparing curricula enabled teaching staff to concentrate on creative and pedagogical aspects of their work. This also contributed to improving teaching quality and increasing teachers' satisfaction with their work. Moreover, the implementation of an automated system for analysis and planning facilitated the individual approach to student learning, resulting in a more accurate educational trajectory and an improvement in student performance. As a result, teachers could spend more time developing innovative teaching methods and creating a conducive learning environment.

5. Improving interactivity and engagement

The implementation of neural networks allowed for the creation of more interactive and entertaining educational materials. Multimedia presentations, virtual laboratories, and simulations assisted in making the learning process more dynamic and interesting, which in turn increased student engagement. Neural networks' adaptive capabilities enable the customization of training materials to individual student needs and knowledge levels, leading to a deep understanding of complex topics (Nwankwo M.C.) [18].

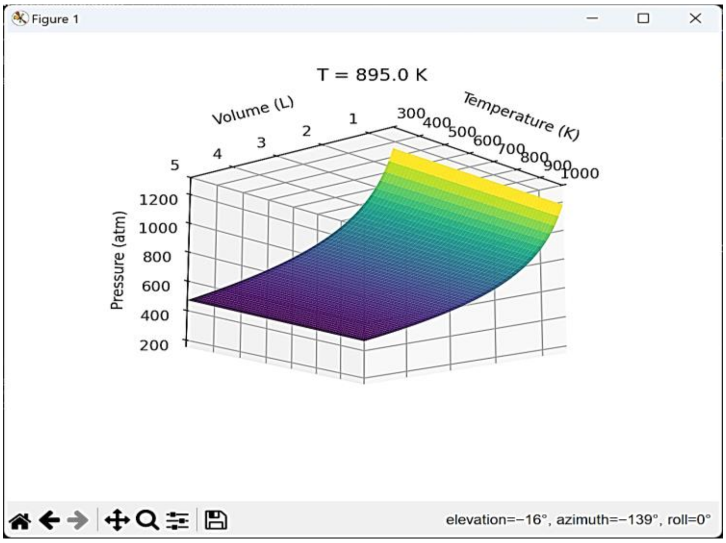


Figure 2 – The result of the adiabatic process virtual work

Figure 2 displays the adiabatic process's virtual work using neural networks. The first step is to collect data on system parameters, such as pressure, volume, and temperature, as shown in the graph. Data obtained from experiments and simulations is cleaned and normalized for neural network improvements. This includes removing missed values, normalizing the value range, and separating data into training and test sets. As the image is three-dimensional, multilayer perceptron (MLP) neural network architecture is employed during the analysis. The model is trained on training data sets using algorithms of backpropagation and gradient descent. During the training process, the neural network adjusts its weights to minimize the prediction errors. After training, the model is tested on a test dataset, prediction accuracy is assessed, and if necessary, the model is refined by changing hyperparameters and architecture. The trained model is used for predicting system parameters. In this case, the model can predict the pressure based on the initial value of volume and temperature (Abaniel A.) [19].

The prediction results are analyzed and compared with actual data sets or theoretical models. This helps to determine the accuracy and reliability of neural networks. The prediction results are visualized for illustration. In this case, a 3D chart can be used to demonstrate pressure dependence on temperature and volume. This approach enables students to comprehend the utilization of neural networks in the analysis and prediction of complicated systems, as well as visualize the results for a better understanding of processes. It is also necessary to consider thermodynamic principles and relevant formulas to describe the neural network-based adiabatic process. The adiabatic process is characterized by that there is no heat exchange with the environment. The main formula for the adiabatic process is the following:

$$PV^{\Upsilon} = const \quad (1)$$

Where:
P — pressure,
V — volume,
Υ — adiabatic index (heat capacity ratio $\frac{C_p}{C_v}$).

Use of neural networks

1. Formula for predicting the pressure with neural networks:

$$P = f(V, T) \quad (2)$$

Where:
P — pressure (output value),
V — volume (input value),
T — temperature (input value),
f — function, trained neural network
2. Normalizing input data:
To improve the model training, data is often normalized:

$$V' = \frac{V - \mu V}{\sigma V} \quad (3)$$

$$T' = \frac{T - \mu T}{\sigma T} \quad (4)$$

Where:
μV and σV — average value and standard volume deviation,
- μT и σT — average value and standard temperature deviation

3. Neural network design:
The use of neural networks possesses the following structure:

$$P = W_3 * relu(W_2 * relu(W_1 * [V', T'] + b_1) + b_2) + b_3 \quad (5)$$

Where:
W_1, W_2, W_3 — layer weight,
b_1, b_2, b_3 — layer displacement,
$relu$ — activation function ReLU (Rectified Linear Unit).

Formulas for training models

1. Loss function:
The loss function is used to train models, such as mean square error:

$$Loss = \frac{1}{n}\sum_{i=1}^{n}\left(P_{pred,i} - P_{true,i}\right)^2 \quad (6)$$

Where:
$P_{pred,i}$ — predicted pressure,
$P_{true,i}$ — actual pressure
n — number of samples

2. Updating the weights using gradient descent:

$$W_j \leftarrow W_j - \eta \frac{\partial Loss}{\partial W_j} \quad (7)$$

Where:

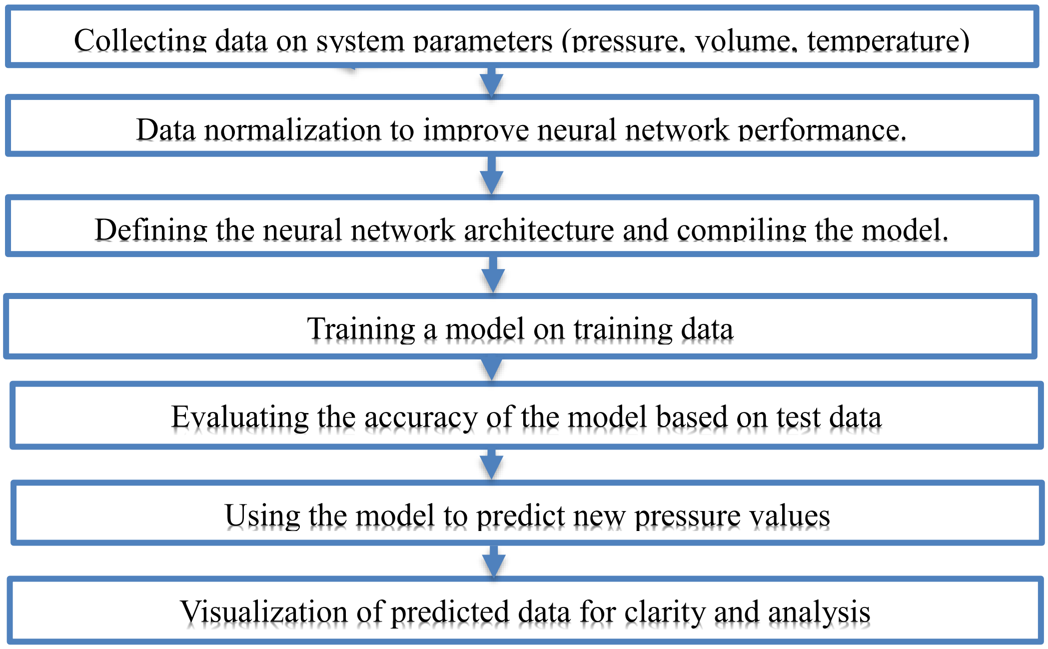
η — training speed,

$\frac{\partial Loss}{\partial W_j}$ — the gradient of the loss function with the weights.

The formulas and approaches given allow students to understand how neural networks can be used for modeling adiabatic processes and predicting system parameters.

The described processes (1) – (7) illustrate the utilization of neural networks in modeling and predicting parameters in an adiabatic process, offering students a clear outline for implementation (Table 1).

Table 1 – The implementation of the adiabatic process with neural networks



1. Data collection and preprocessing

Data collection and pre-processing include several key steps. First, data is collected about system parameters, such as pressure, volume, and temperature. Then the data is cleared, including removing missed values and checking for anomalies. Following this, data is normalized to improve the model training process, which results in more accurate results.

2. Creating and training neural networks

Creating and training neural networks consists of several steps. First, the neural network design is determined, which will be used for taking assignments. Then data is divided into training and test sets to check the model. Then the model is compiled and trained on training data to achieve optimal performance.

3. Evaluation and testing of the model

The evaluation and testing of the model contain the following steps: First, the model is evaluated on the testing data to check its capability to make an accurate prediction. Then an analysis for accuracy and prediction errors is conducted to determine strengths and weaknesses of the model and identify possible areas for improvement.

4. Using the model for prediction

Using the model for prediction includes entering new data into the system for obtaining prediction results. In particular, the model is used for volume value prediction based on entered parameters.

5. The result visualization

The process of visualizing the results involves creating graphs and diagrams that illustrate various system parameters. It not only enables us to understand the model operation better but also compares predicted values with actual data, which helps to assess the accuracy and prediction efficiency.

The process of developing and implementing models based on neural networks for predicting the pressure value involves several key steps, commencing from data collection and preprocessing to the result visualization. During data collection and preprocessing, the focus is paid to the quality of output data that allows for improvement of the model process and provides more accurate predictions. Creating and training the neural networks is aimed at optimizing the model design and its training on appropriate datasets to obtain high productivity.

The model's evaluation and testing enable the identification of its accuracy and potential areas for improvement. The model is then used for predicting new data, which demonstrates its practical value. Visualizing results through graphs and diagrams not only helps to better understand the model operation but also provides an illustrated comparison of predicted values with actual data, which confirms the efficiency and accuracy of developed systems. This holistic approach to neural network design and use contributes to the development of reliable and accurate models for prediction and system parameter analysis.

The description of the next process under consideration is the result of the interference performed by the students of the virtual laboratory demonstrated in the following figures.

Interference – a phenomenon in which two or more waves overlap each other, creating new waves with excellent amplitude depending on the phase shift between the initial waves.

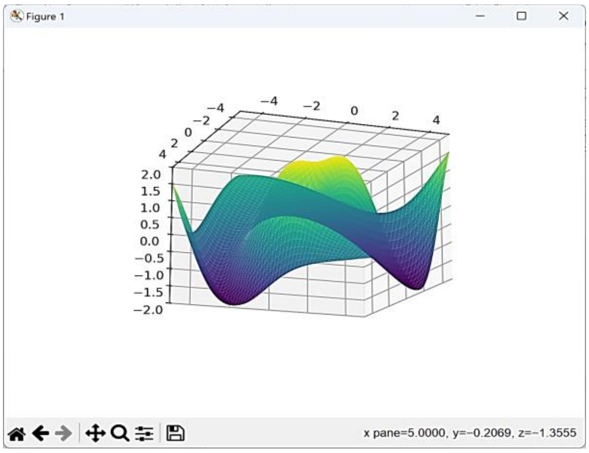


Figure 3 – Interference process from the back side

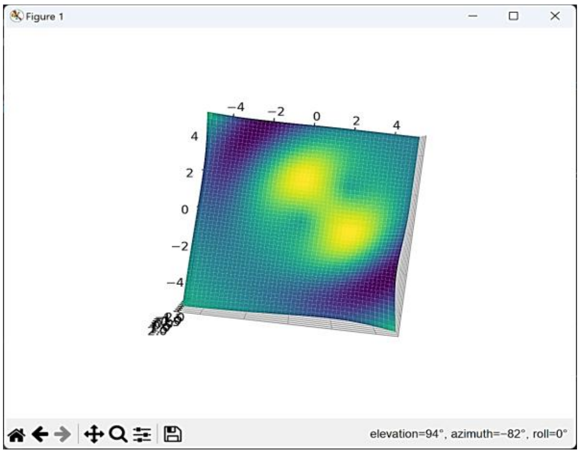


Figure 4 – Interference process from the top side

The interference process illustrated in Figures 3 and 4 show the view from the back and top sides, obtained thanks to visual works made by neural networks.

Overlapping waves lead to new wave formation with changed amplitudes depending on the phase shift of the initial waves. A neural network-based virtual analysis of this phenomenon undergoes several stages, as shown below.

1. Data collection

First, it is necessary to collect data about the wave process parameters that describe the amplitudes and wave phases at different points in space.

2. Data pre-processing

It is necessary to prepare data for use in neural networks. This includes normalization, data scaling, and splitting into training and test samples.

3. Creating and training the neural networks.

A neural network will be used for predicting the interference results based on input data (amplitude and wave phase).

Detailed description of the process

4. Using the model for prediction description of the steps

1. Data collection: Generating or collecting data regarding wave parameters, such as amplitude and phase.
2. Data pre-processing: normalizing and data scaling, splitting into training and test samples.
3. Creating the model: identifying neural network design, and model compilation.
4. Training the model: Training the model on interference data
5. Evaluating the data: model accuracy assessment on test datasets
6. Prediction: Using the model for predicting interference of new data
7. Visualization: Visualizing predicted data for comparison with the initial data

Technology aids students in comprehending the use of neural networks for wave interference analysis and prediction, offering a clear scheme and code examples for practical application. This contributes to in-depth knowledge of neural networks and their implementation in physics assignments, as well as developing programming and modeling skills for intricate phenomena. Additionally, this approach enables students to experiment with various model parameters and observe how such changes impact the results, which strengthens their understanding of both interference principles and machine learning methods.

Adjustments and improvements of models: Regularization methods such as dropout and L2-regulation were used to prevent retraining. Based on the obtained data, reassessment, and model adjustment were periodically carried out.

The use of neural networks in teaching physics at university showed a significant advantage, including adaptivity and personalization of the learning process. Methods applied in the research allowed for the development and testing of effective educational tools that can be integrated with existing curricula to improve education quality.

6. Expanding the distance learning opportunities

Neural network-based technologies demonstrated their high efficiency in distance learning, especially recently relevant due to global changes in the educational sphere. The technologies allowed for the creation of interactive and adaptive learning systems, which could compensate for a lack of personal contact between teachers and students. Artificial intelligence-based systems not only automate checking and assessing the assignments but also recommend personalized learning materials tailored to the individual needs of each student. The interaction became more dynamic and continuous, which helped to maintain a high level of engagement and motivation for students even in a remote format. Using neural networks in teaching showed its value in improving the quality of education, reducing barriers related to the physical absence of a teacher, and providing students with the necessary support at every stage of their studies.

7. Implementing the innovative teaching methods

The use of artificial intelligence in teaching physics allowed for the implementation of innovative teaching methods, such as gamification and adaptive learning. This not only made the learning process more engaging but also facilitated a more in-depth exploration of topics studied, stimulating their interest in subjects.

The research revealed that implementing neural networks in teaching physics at university has numerous benefits, including enhancing learning personalization, assessment optimization, improvement of students' academic performance, reducing teachers' workload, improving interactivity and engagement, increasing distance learning opportunities, and implementing innovative teaching methods. The results reveal AI's significant potential in education and the necessity of further development and implementation of such technologies.

Discussion

The research results show that implementing neural networks in teaching physics at universities can significantly improve education quality. Neural networks enable the creation of adaptive educational systems that adapt to the individual needs of students, providing personalized training materials and assignments.

One of the key aspects of our research was to explore the effects of neural networks on students' academic performance. Data analysis showed that students who used neural network-based adaptive educational systems demonstrated higher academic results than the control group. This is because such systems allow students to study the material at a convenient pace and focus on the topics that cause the most difficulty.

Personalized learning is one of the benefits of implementing neural networks. Our study revealed that neural network-based systems can adapt training materials in real time, based on the midterm test results and students' engagement. This allows students to get more targeted assistance and acquire complex concepts effectively.

Creating visual laboratories and simulations based on neural networks proved to be an effective tool to improve understanding of complex physical processes. The virtual laboratories enabled students to conduct experiments and visualize results in an interactive environment, which significantly improved their involvement and interest in learning physics. However, implementing such technologies requires significant development and testing efforts, as well as the availability of appropriate infrastructure.

Implementing neural networks for assessing students' knowledge and providing feedback has also shown positive results. These systems assist in identifying the strengths and weaknesses of each student and offering individualized recommendations for improving their academic performance. However, for the full implementation of these technologies, there is a need for further research and improvement of evaluation algorithms to provide reliability and accuracy.

Despite the positive results, our research revealed several issues and limitations. Firstly, implementing neural networks in the educational process requires significant resources and time to create and install the system. Secondly, not all teaching staff and students are ready to use new technology, which requires additional effort of training and adaptation. Thirdly, there is a need for constant updating and maintaining the developed system so that it remains relevant and effective.

Our research opens up wide perspectives for further research in using neural networks in education. It is important to study and develop new methods and approaches aimed at improving adaptivity and personalization of educational systems. Particular emphasis should be given to integrating neural networks with other innovative technologies, such as augmented and virtual reality, for creating more interactive and engaging learning materials.

The use of neural networks in teaching physics at universities showed its efficiency in improving education quality and students' academic performance. Despite the existence of issues and limitations, the advantages of such systems significantly outweigh their potential drawbacks. It is also important to study and develop this direction to provide modern and quality education for future generations of students.

Conclusion

During the research, opportunities for implementing neural networks in teaching physics in higher education were considered. The results demonstrate significant advantages of using this technology to improve educational processes.

The main outcomes of the research include the following aspects:

1. Improving academic performance: students who used neural network-based adaptive educational systems showed high results in education. This is due to each student's individual approach and opportunities to focus on complex, hard-to-understand topics.

2. Personalized learning: Neural networks allow the creation of personalized learning materials, adapted to the needs and knowledge levels of each student. This significantly improves the perception and material assimilation.

3. Interactive virtual laboratories: neural network-based virtual laboratories and simulations provide students with opportunities to conduct experiments and visualize the results in an interactive environment. This results in an in-depth understanding of complex physical processes and enhances the interest in learning the subject.

4. Precise knowledge assessment: the use of neural networks for students' knowledge assessment and providing feedback allows identifying the strong and weak points, which contributes to improving students' academic performance.

Despite the identified problems and limitations, such as the necessity of resources for developing and implementing systems, as well as a need for training teaching staff and students on new technologies, the research revealed that the advantages of neural networks outweigh the challenges.

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ЖОҒАРЫ ОҚУ ОРЫНДАРЫНДА ФИЗИКАНЫ ОҚЫТУДА НЕЙРОНДЫҚ ЖЕЛІЛЕРДІ ҚОЛДАНУДЫ ЗЕРТТЕУ ЖӘНЕ ТАЛДАУ

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Аңдатпа. Инновациялық технологияларды енгізу қазіргі білім беру процесінде білім сапасын арттырудағы негізгі фактор болып табылады. Зерттеудің мақсаты — жоғары оқу орындарында физиканы оқытуда нейрондық желілерді қолдануды зерттеу және талдау. Негізгі назар қазіргі жасанды интеллект (ЖИ) технологияларын оқу процесін жақсарту үшін қолданудың тиімділігі мен мүмкін артықшылықтарын талдауға аударылған. Зерттеу барысында нейрондық желілерді бейімделген білім беру жүйелерін, персонализацияланған оқу бағдарламаларын және виртуалды зертханаларды құру үшін қолданудың әртүрлі тәсілдері пайдаланылды. Арнайы назар бұл технологиялардың студенттердің академиялық көрсеткіштеріне, оқу процесіне қатысуына және күрделі физикалық ұғымдарды түсінуіне әсеріне бөлінді. Зерттеу әдістемесі ағымдағы әдебиеттерді шолу, нейрондық желілерді оқу процесінде қолдану эксперименттері және студенттер мен оқытушылардан алынған сауалнамаға негізделген. Эксперименттер кезінде әртүрлі нейрондық желі модельдері, атап айтқанда рекуррентті нейрондық желілер (RNN) және терең нейрондық желілер (DNN), академиялық көрсеткіштерді болжау, персонализацияланған оқыту және оқу материалдарын автоматты түрде жасау мәселелерін шешу үшін қолданылды. Зерттеу нәтижелері нейрондық желілерді физиканы оқытуда қолдану оқытудың сапасын едәуір арттыра алатынын, әр студентке жеке тәсіл жасауға ықпал ететінін және оқытушылардың рутиндік тапсырмаларын жеңілдететінін көрсетті. Сонымен қатар, ЖИ оқу процесінде өзара әрекеттестік пен бейімделгіштік арқасында студенттердің физика және байланысты пәндерге қызығушылығын арттыра алады. Жоғары оқу орындарында физиканы оқытуда нейрондық желілерді енгізу – әрі қарай зерттеуді және дамытуды қажет ететін перспективалы бағыт болып табылады.

***Кілт сөздер**: нейрондық желілер, процесс, адиабаттық процесс, виртуалды зертхана, эксперимент, технология, болжам, жасанды интеллект.*

ИССЛЕДОВАНИЕ И АНАЛИЗ ПРИМЕНЕНИЯ НЕЙРОННЫХ СЕТЕЙ В ПРЕПОДАВАНИИ ФИЗИКИ В ВУЗАХ

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Аннотация. Внедрение инновационных технологий является ключевым фактором повышения качества образования в современном образовательном процессе. Цель исследования – изучить и проанализировать применение нейронных сетей в преподавании физики в высших учебных заведениях. Основное внимание уделяется анализу эффективности и потенциальных преимуществ использования современных технологий искусственного интеллекта (ИИ) для совершенствования процесса обучения. В исследовании использовались различные подходы к применению нейронных сетей для создания адаптивных образовательных систем, персонализированных программ обучения и виртуальных лабораторий. Особое внимание уделено влиянию этих технологий на учебную успеваемость студентов, их вовлечённость в образовательный процесс и понимание сложных физических понятий. Методология исследования включает обзор существующей литературы, эксперименты с использованием нейронных сетей в учебном процессе и опрос студентов и преподавателей. В ходе экспериментов использовались различные модели нейронных сетей, а именно рекуррентные нейронные сети (RNN) и глубокие нейронные сети (DNN), для решения задач прогнозирования успеваемости, персонализированного обучения и автоматического создания учебных материалов. Результаты исследования показывают, что применение *нейронных сетей в преподавании физики может значительно повысить качество обучения, способствовать индивидуальному подходу к каждому студенту и облегчить рутинные задачи преподавателей. Более того, ИИ способен стимулировать интерес студентов к изучению физики и смежных дисциплин благодаря своей интерактивности и адаптивности в образовательном процессе. Внедрение нейронных сетей в преподавание физики в высших учебных заведениях представляет собой перспективное направление, требующее дальнейшего изучения и развития.*

Ключевые слова: *нейронные сети, процесс, адиабатический процесс, виртуальная лаборатория, эксперимент, технология, прогнозирование, искусственный интеллект.*