

# Research on AI-Enabled Single-Chip Microcomputer Teaching Quality Based on Neural Networks

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**Abstract:** With the gradual penetration of artificial intelligence technology into the field of education, to explore the application value of Generative Artificial Intelligence (AIGC) in traditional teaching, this paper sorts out the innovative application models of AIGC with the single-chip microcomputer course as the research object. By comparing and analyzing the teaching achievements of this course in the two academic years of 2024–2025, the effectiveness of AI empowerment in improving the teaching quality of single-chip microcomputers is verified. Meanwhile, based on the Back Propagation neural network algorithm, a prediction model for students' final exam scores is constructed by integrating multidimensional data such as students' classroom performance, experimental report scores, and phased test results. After training and verification, the prediction accuracy of the model on the test set reaches 76.9%.

**Keywords:** Single-chip microcomputer; Generative Artificial Intelligence; Blended teaching; Back Propagation neural network; Prediction model

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## 1. Introduction

In recent years, the application of artificial intelligence in the field of education has become increasingly in-depth. However, in the teaching process of the single-chip microcomputer course, Generative Artificial Intelligence (AIGC)-assisted teaching still lacks support from specific practical cases. The traditional single-chip microcomputer application course has problems such as outdated design topics, insufficient role of instructors, and unreasonable evaluation methods <sup>[1]</sup>. The innovative concept of basic principles of single-chip microcomputers also puts forward higher requirements for innovative practical courses <sup>[2]</sup>. As a cutting-edge technology in the field of AI, AIGC has promoted educational transformation due to its generalization and natural language interaction capabilities compared with other educational technologies <sup>[3]</sup>. According to a 2024 survey by the Digital Education Council, most students (86%) use artificial intelligence in their

studies. Data from a 2024 survey by Educause shows that the application penetration rate of AIGC in general education courses in global universities has reached 37%, but it is still in the exploration stage in the field of professional core courses, especially engineering courses. Deepening curriculum reform is the focus of China's undergraduate education and teaching reform at present and in the future, and digital and intelligent education has become the trend of future education development <sup>[4]</sup>. AI technology can assist teachers in efficiently completing teaching tasks, and at the same time, teachers can more accurately grasp students' learning status to further improve teaching effects <sup>[5]</sup>. How to transform the content generation and intelligent interaction characteristics of AIGC into practical teaching strategies in the field of engineering education has become the key to the current digital transformation of education.

Back Propagation (BP) neural network is an artificial neural network based on the error back propagation algorithm, which is widely used <sup>[6]</sup>. Gao used online learning behavior data to analyze students' learning behaviors to predict final exam scores, identified factors that have a significant impact on students' academic performance, and teachers can focus on and warn students at risk of failing exams before the exam. The accuracy rate of score prediction on the test set reached about 70% <sup>[7]</sup>. This paper integrates AIGC and BP neural network technology, takes the single-chip microcomputer course as the research object, constructs a score prediction model, and compares the data of the experimental group (AI-enabled class) and the control group (traditional teaching class) in the 2024–2025 academic year to verify the effectiveness of AI-enabled teaching in improving students' knowledge mastery and practical abilities, so as to assist the intelligent transformation of education.

## 2. Technical support

### 2.1. Overview of AIGC technology

The application of Generative Artificial Intelligence in the field of education is becoming increasingly widespread. AIGC technology can quickly generate teaching materials, auxiliary materials, and other content, helping teachers or educational institutions improve teaching efficiency and quality <sup>[8]</sup>. Research related to AIGC can be traced back to the 1950s, but the technological development was hindered by multiple factors such as the growth of data scale, the improvement of computing power, and algorithmic innovations. With technological iteration, after 2010, the innovation of deep learning algorithms and the emergence of large-scale pre-trained models have led to the widespread application of AIGC in various fields <sup>[9]</sup>. AIGC technology has potential value in empowering the field of education, helping education achieve a higher level of targeting, timeliness, and collaboration <sup>[10]</sup>. How to combine advanced AI technology with pedagogy, psychology, and educational technology to adapt to complex teaching scenarios and achieve more scientific and effective intelligent decision-making is the focus of future research <sup>[11]</sup>.

### 2.2. BP neural network

Artificial neural network is a network system constructed on the basis of human understanding of the biological nervous system that can realize nonlinear mathematical modeling, and has formed multiple research schools in its long-term development <sup>[12]</sup>. BP neural network refers to the model updating weights by gradient descent in the direction of reducing errors. As a classic supervised learning model with high theoretical maturity, it has the classic capabilities of lightweight application and interdisciplinary integration <sup>[13]</sup>. It receives raw data from the input layer and transmits information unidirectionally to the output layer. There is no connection between neurons in the same layer, and a direct cross-layer connection is not allowed. This unidirectionality of information flow simplifies the network learning process <sup>[14]</sup>. By reasonably selecting learning algorithms, optimization strategies, and hyperparameter tuning, BP neural networks can achieve good performance in various complex

tasks<sup>[15]</sup>.

### 3. Research design

The research objects were 8 parallel teaching classes of the “Principle and Interface Technology of Single-Chip Microcomputers” course in 2025, with a total sample size of 375 students. Students in the parallel classes were all from the same grade of computer-related majors, with similar entrance scores and basic knowledge of prerequisite courses, ensuring the comparability of teaching experiments. The final score data collected from 8 classes were divided into a training set (scores of 6 classes) and a test set (scores of 2 classes) at a ratio of 3:1 to construct, train, and verify the effectiveness of the BP neural network model. Process data such as daily attendance, homework, experiments, and project defenses were used as inputs, and the risk prediction results of final scores were output. Finally, the traditional teaching class taught by the same teacher in 2024 was selected as a control. The consistency between predicted and actual scores was verified through error indicators, and the average score, variance, and other statistics of class scores before and after AI empowerment were compared by controlling variables to analyze the score change trend.

## 4. Results and analysis

### 4.1. BP neural network prediction results

The model adopts a three-layer architecture. The input layer has 1 neuron receiving 4-dimensional features, the hidden layer has 100 neurons outputting 100-dimensional features through linear transformation and activation function, and the output layer predicts the score passing status. **Figure 1** shows the correlation characteristics between the predicted scores and actual scores of the BP neural network through four groups of fitting scatter plots. The linear trend of the fitting line reflects the adaptability between predicted values and real scores, and the density of scatter distribution and the degree of fitting to the fitting line reflect the adaptability of the model to different data subsets. The higher the fitting degree, the stronger the prediction accuracy. The correlation coefficient (R) is used to quantify the linear correlation between predicted scores and actual scores, with a value range of [-1,1]. The larger the absolute value, the more significant the linear correlation.

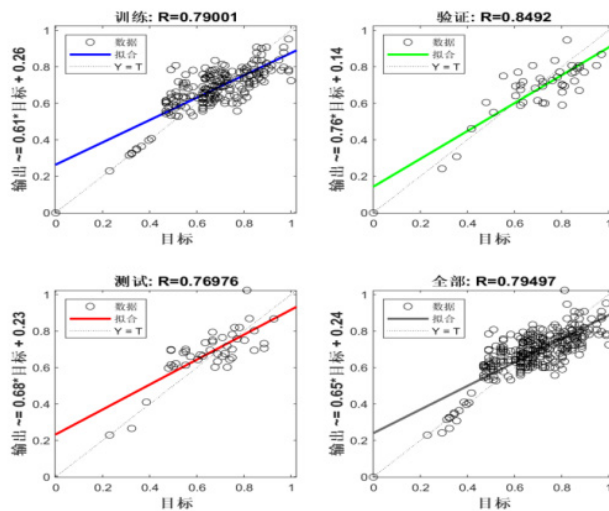


Figure 1. Neural network training, validation, and test data

It can be seen from **Figure 1** that the training set has  $R = 0.79001$ , indicating a moderate positive correlation between prediction and actual scores, which can capture data rules, but there is still room for optimization in fitting. The validation set has  $R = 0.8492$ , with improved correlation, indicating that the model has good generalization ability and effectively suppresses overfitting. The test set has  $R = 0.76976$ , with slightly lower correlation. Affected by samples and features, the local fitting effect decreases. The full data set has  $R = 0.79497$ , with an overall correlation close to that of the training set. The model can stably map the relationship between features and scores, and has basic prediction ability, which can provide data support for teaching analysis.

The dynamic gradient of BP neural network training decreases overall, and back propagation effectively adjusts weights to reduce errors. Local fluctuations are normal learning phenomena. The Mean Squared Error (MSE) of the performance verification curve for 16 rounds reflects the average deviation between predicted values and true values, showing the convergence characteristics and generalization ability of model training. The key round 10 has the best verification performance ( $MSE = 0.0098632$ ), and the validation set has the best fitting effect on new data. The MSE does not decrease in subsequent iterations, indicating that the model has reached a convergent steady state, and further training is difficult to break through the performance bottleneck. In summary, the MSE of the training set, validation set, and test set finally approaches and stabilizes at a low level (about 0.01), indicating that the model has strong fitting ability and good generalization.

## 4.2. Analysis of students' final exam scores

The pass rate of the AI-enabled class (Class A) in the 2024–2025 academic year is about 97.78%, which is higher than 91.11% of the traditional teaching class (Class B) in the 2023–2024 academic year. Students' comprehensive scores have improved significantly. The average midterm exam score has increased from 68 to 69, and the pass rate has risen from 73.9% to 80.9%. The score variance of the 2025 academic year has decreased from 145.56 to 91.18, the score distribution is more concentrated, and the normal distribution characteristics are more significant. The average score of Class A is 82, higher than 73 of Class B, and the variance is 329.87, smaller than 360.87 of Class B. The scores of Class A are more balanced with smaller fluctuations, while the scores of Class B are mostly concentrated in the medium and below levels with larger score gaps.

## 5. Conclusion

Research on BP neural networks in AI-enabled single-chip microcomputer course teaching quality shows that integrating artificial intelligence technology to assist single-chip microcomputer course teaching can stimulate classroom vitality. This algorithm is classic, universal, and has a clear structure. The constructed score prediction model has an accuracy rate of 76.9%, which can provide teachers with pre-exam evaluation and early warning. The study uses student data from two academic years to train the model, and the verification effect is good. In the future, we will optimize the sensitive factor extraction method, add prediction conditions related to teaching and learning to improve model performance, and lay the foundation for constructing a more accurate score prediction model and optimizing teaching quality.

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## Disclosure statement

The authors declare no conflict of interest.

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