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Enhancing the Competence of College Counselors in Student Education through Big Data Algorithms

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ABSTRACT

This paper aims to explore the path of enhancing the competence of college counselors in student education through big data algorithms. A review of relevant research progress both domestically and internationally found that big data algorithms have great potential for application in student education in colleges and universities. Addressing the challenges faced by college counselors in improving their competence, a set of paths based on big data algorithms is proposed, including technological, methodological, mechanistic, and algorithmic innovations. Finally, a series of experiments are designed, and the results are analyzed to validate the effectiveness of the proposed path. The research results indicate that the path of enhancing the competence of college counselors based on big data algorithms can effectively improve their student education capabilities and provide strong support for enhancing higher education quality.

Keywords: Big Data Algorithms, College Counselors, Competence, Enhancement Path

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1. Introduction

Higher education is essential to social development and progress, carrying the mission of nurturing talents, promoting scientific research, and driving social advancement. As a vital part of higher education, the work of college counselors plays a crucial role in the development and growth of students [1,2]. Counselors provide important guidance and support in students' individual development, psychological well-being, academic planning, and career development, playing a significant role in their comprehensive development.

However, with the continuous expansion of higher education and the diversification of student groups, college counselors are facing increasing challenges. Firstly, there needs to be more counselors. Some colleges need more counselor teams to meet the demands of students, resulting in overwhelming workloads for counselors, making it difficult to fully address the individual needs of each student [3,4]. Moreover, there are cases of insufficient professional competence and capabilities among counselor teams, leading to ineffective guidance and support. Secondly, information acquisition and processing pose certain difficulties. Due to the large number of students, counselors find it challenging to comprehensively understand each student's situation and accurately grasp their needs and issues [5]. Additionally, the increase in individual differences and complexity among students presents challenges to counselors, as traditional generalized counseling approaches struggle to meet the needs of different students.

In this context, the application of big data algorithms provides new ideas and methods for the work of college counselors in student education. The development of big data technology enables colleges to collect, store, and process vast amounts of student data, such as learning records, course selections, psychological health assessments, etc., providing counselors with abundant information resources [6,7]. By utilizing big data algorithms, student data can be mined and analyzed, extracting their characteristic information, needs, and issues, enabling counselors to provide accurate guidance and support [8]. Additionally, big data algorithms can offer personalized counseling and intelligent recommendations to counselors, providing targeted interventions and suggestions to help students better solve problems and achieve their personal development goals.

The path of enhancing the competence of college counselors in student education based on big data algorithms holds significant practical value. The application of big data algorithms can assist counselors in better understanding students' needs and issues, providing them with personalized guidance and support [9]. This paper aims to explore the path of enhancing the competence of college counselors in student education based on big data algorithms and demonstrate its effectiveness through experiments. It provides new ideas and methods for the work of college counselors and contributes to the enhancement of higher education quality.

2. Application Progress of Big Data Algorithms in Enhancing the Competence of College Counselors

Scholars both domestically and internationally have extensively researched the path of enhancing the competence of college counselors in student education through big data algorithms. In terms of technology, researchers use data mining, machine learning, and artificial intelligence techniques to analyze and mine student behavioral data, extracting student behavior patterns, characteristic information, and learning rules [10]. For example, by analyzing students' learning behavior data, their learning preferences and difficulties can be discovered, providing personalized learning advice and counseling plans to counselors. In terms of methods, researchers have explored personalized counseling and intelligent recommendation methods based on big data algorithms. By analyzing and matching students' characteristic information, counselors can provide targeted counseling plans and advice, helping students better solve problems and achieve their development goals [11]. In terms of mechanisms, researchers have constructed a complete student management and counseling system, achieving information sharing and resource integration. By establishing student records and counselor work platforms, student information can be shared, and counselors can work collaboratively. In terms of algorithms, researchers have developed various algorithm models, such as cluster analysis, decision tree algorithms, and deep learning algorithms, to achieve precise student prediction and intervention. These algorithm models can model and train student data, providing counselors with more accurate student assessments and predictions.

However, in the progress of research both domestically and internationally, the path of enhancing the competence of college counselors in student education based on big data algorithms also faces some issues and challenges. When applying big data algorithms for student data analysis, data privacy and security are critical concerns. Students' personal information and sensitive data need protection to prevent misuse or leaks. Therefore, when designing and implementing big data algorithms, corresponding privacy protection and data security measures must be taken to ensure the safety and privacy of student data. The effectiveness and reliability of big data algorithms depend on the quality of data [12,13]. However, student data may have quality issues such as missing, erroneous, or incomplete data, which may affect the analysis results and accuracy of algorithms. Researchers need to address data quality issues, implement data cleaning and correction measures, and improve the accuracy and reliability of data. In the path based on big data algorithms, selecting appropriate algorithm models is crucial for effective student analysis and prediction. However, for the work of college counselors in student education, different algorithm models may have different advantages and disadvantages, and adjustments and optimizations need to be made based on specific situations. Therefore, researchers need to conduct in-depth studies on algorithm selection and optimization to improve algorithm performance and adaptability. When using big data algorithms for student analysis, ethical considerations are involved [14,15]. For example, how to balance the protection of students' personal privacy and the effectiveness of algorithms, and how to avoid unfair impacts on students. Researchers need to address and resolve these ethical issues to ensure that the use of algorithms is lawful, fair, and ethical. The application of big data algorithms in the work of college counselors is a technical means, but counselors' work also needs to focus on human care and emotional support [16]. While promoting the application of algorithms, researchers should also consider how to balance the integration of technology and humanities to ensure that counselors can provide emotional support, encouragement, and listen to students' needs, rather than solely relying on algorithm analysis and recommendations.

3. Selecting Appropriate Algorithms and Establishing the Counselor Competence Enhancement System

3.1 Selection of Neural Network Algorithm

The neural network algorithm is a type of machine learning algorithm based on artificial neural networks. Inspired by the interconnectedness and information transmission between neurons in the human brain, the neural network algorithm simulates the learning and decision-making processes of the human brain through a network structure composed of multiple layers of neurons. The core of the neural network algorithm is the neuron, each of which receives input signals from other neurons, performs weighted summation of these inputs through an activation function, and then produces an output. Neural networks typically consist of input layers, hidden layers, and output layers, with multiple hidden layers possible. The output of each neuron serves as input to the next layer of neurons, enabling information propagation for computation and learning.

The learning process of the neural network algorithm typically includes two main stages: forward propagation and backward propagation. In the forward propagation stage, input data pass through the network, undergo a series of weighted summations and activation function operations, and finally yield output results. In the backward propagation stage, based on the discrepancy between the predicted results and the actual results (loss function), the algorithm adjusts the network parameters (weights and biases) through backward error propagation, gradually making the network's output approach the actual results. This process iterates until the network achieves the predetermined performance metric or converges.

The strength of the neural network algorithm lies in its ability to automatically learn features and patterns from

data, with strong nonlinear fitting capability. It is widely applied in various fields such as image recognition, speech recognition, natural language processing, recommendation systems, etc. With the rise of deep learning, deep neural networks have become an important branch of the neural network algorithm, increasing the algorithm's expressive power and performance by adding depth and complexity to the network.

Neural network algorithms can learn and design from raw features and achieve high-dimensional feature representation through unsupervised training. The selected neural network algorithm for this study, based on factorization machines, can use FM for recurrent supervised learning, effectively reducing sparse features and obtaining continuous dense features. Above the embedding layer, this experiment constructs a multi-layer FNN for the design of the digital art model.

Through one-hot encoding, the FNN algorithm takes categorical features as input and represents them in a subdomain manner. It has multiple units, with each representing a specific field, with only one positive value and others being negative. The encoded features are represented as shown in Figure 1.

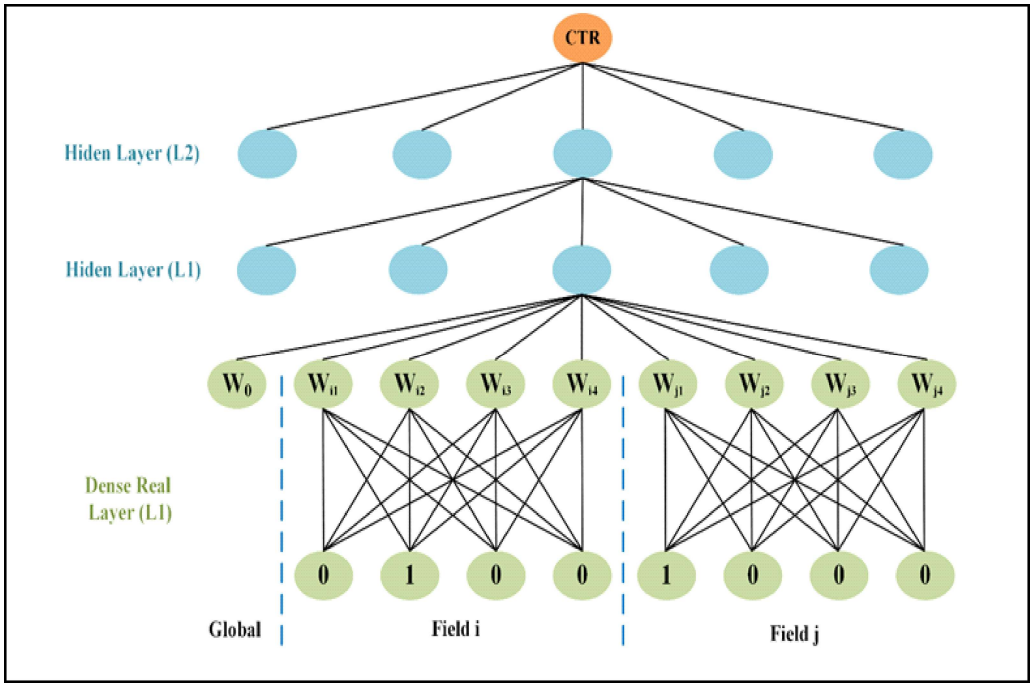

Figure 1. Structure Diagram of the Four-layer FNN Algorithm Model

3.2 Establishment of Counselor-Related Models Based on Algorithms

The establishment of the counselor competence enhancement model based on neural network algorithms involves the following steps. Firstly, collect relevant data concerning counselors and students, such as students' personal information, academic performance, psychological health assessments, as well as counselors' professional background and work experience. Ensure the quality and accuracy of the data and perform necessary data cleaning and preprocessing. Extract appropriate features from the collected data based on the assessment indicators and objectives of counselor competence. These features may include students' learning behaviors, psychological states, interests, as well as counselors' educational experiences, and professional backgrounds. Concurrently, conduct feature selection to identify the most influential features on counselor competence.

Considering the complexity of the problem and the dimensionality of the features, design an appropriate neural network structure. In this study, the model is established with the topmost layer outputting a real number and the bottommost layer being the FM layer. The probability of a click is represented by the following formula:

$$\hat{y} = sigmoid(W_3 l_2 + b_3) \tag{1}$$

The l in the equation is the input feature of its layer, which can be calculated through the formula.

$$l_2 = \tanh(W_2 l_1 + b_2) \tag{2}$$

Through the above calculation steps, the FNN algorithm can improve the model learning ability and obtain more potential data relationships. Continuing to add the weights of the hidden layer to the algorithm model for calculation, and choosing to use SGD to predict FM weights can effectively reduce the computational workload. First, use the cross Loss function to initialize all four layers

$$L(y, \hat{y}) = -y \log \hat{y} - (1 - y) \log(1 - \hat{y}) \tag{3}$$

Comparing the two, it can be found that L1 regularization is more inclined towards smaller scale algorithm models because its calculated solution has stronger sparsity. Therefore, for outlier features, L1 regularization will not give too much weight, and the resulting results will lose some accuracy. At the same time, in order to avoid overfitting, this study uses L2 regularization, and the regularization process is as follows:

$$\Omega(w) = 2\|W_0\| + \sum l = 3\left(\|W_l\|^2 + \|b_l\|^2\right) \tag{4}$$

Furthermore, the data was split into training and testing sets, and the neural network model was trained using the training set. During the training process, the network parameters were adjusted through the backpropagation algorithm and an optimizer to minimize the loss function. Common optimization algorithms, such as gradient descent or adaptive moment estimation, can be used. Additionally, methods like cross-validation were employed to evaluate and optimize the model, ensuring its performance and generalization ability. The trained model was evaluated using the testing set, and performance metrics such as accuracy, precision, and recall were analyzed. Moreover, interpretability techniques, such as feature importance analysis or neural network interpretability methods, were used to understand the model's impact on decision-making and interpret its decision process. The trained model was then applied in practical counseling work for counselors, providing guidance and support based on the model's predictions and recommendations. Iterations and improvements were made to the model based on feedback and results from actual applications, aiming to enhance the model's performance and adaptability.

4. Application of the Data Model in Practice

In collaboration with a certain university, this experiment obtained the consent to access the academic performance data and basic personal information of first to fourth-year students. Additionally, data on the learning and living conditions of nearly 1000 university students were collected through actual visits and distributed questionnaires both online and offline. This research initially conducted statistical analysis on the gender and grade distribution of the participating students, and the results are shown in Figure 2

From the results, it can be observed that the gender proportion of college students is close to 50%, with slightly fewer male students than female students. The number of students in each grade of the participating university

is relatively evenly distributed, with first-year students accounting for 30% of the total, second-year students 26%, third-year students 24%, and fourth-year graduating students making up the lowest proportion of 20%. The statistical results indicate that both the gender and grade proportions are close to their normal distributions, suggesting that the data is reliable and suitable for the study.

The data obtained above was input into the system, and 60 college students from the second year with a low GPA rating of 1 were divided into two groups, with each group comprising 30 students. Group A students were assigned counselors who used the algorithm to establish the model, while Group B students were assigned traditional counselors as the control group. The living and teaching environments were kept the same for both groups. A comparative control experiment was conducted over 3 months, and grade assessments were conducted at the end of each month. The results obtained are shown in Figure 3.

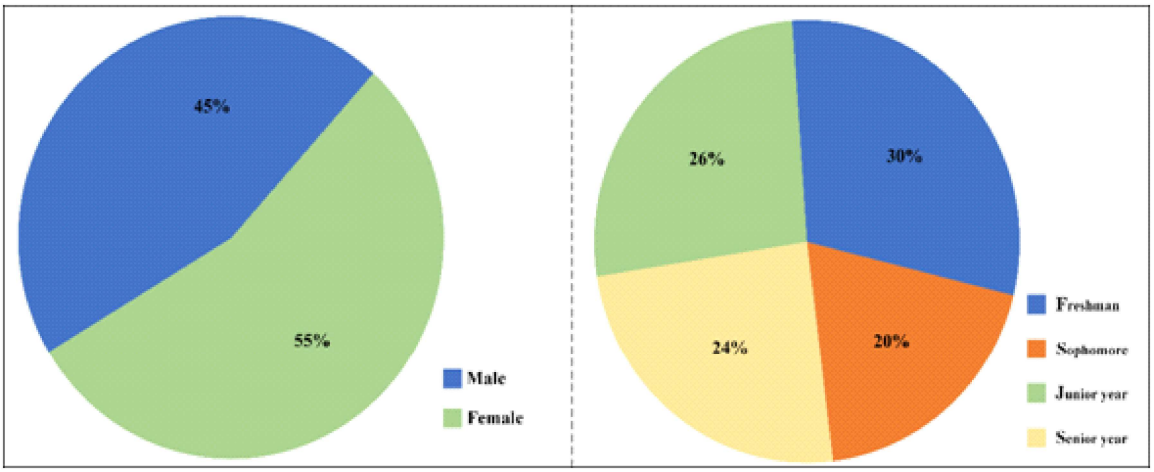

Figure 2. Distribution of Gender and Grade Proportions of Participating College Students in the Experiment

From Figure 3, it can be observed that after three months of the experiment, students in Group A, who were educated by counselors using the algorithm model, showed a steady improvement in academic performance, reaching a nearly excellent level by the end of the experiment. Additionally, their life skills also improved to varying degrees, with an average increase of approximately 25 points in their grades among the 30 students. In contrast, the control Group B, who had traditional counselors, showed no significant changes in academic performance and life skills. This indicates the effectiveness of the data model based on big data algorithms in the practical application of counselors' work.

5. Conclusions

This study aimed to establish a model for enhancing the educational capacity of counselors based on neural network algorithms. By going through the steps of data collection and preparation, feature extraction and selection, network structure design, model training and optimization, model evaluation and interpretation, as well as model application and iteration, a model capable of assisting counselors in personalized guidance and decision support was constructed.

This model takes advantage of neural networks to extract key features related to educational capacity from data of counselors and students.

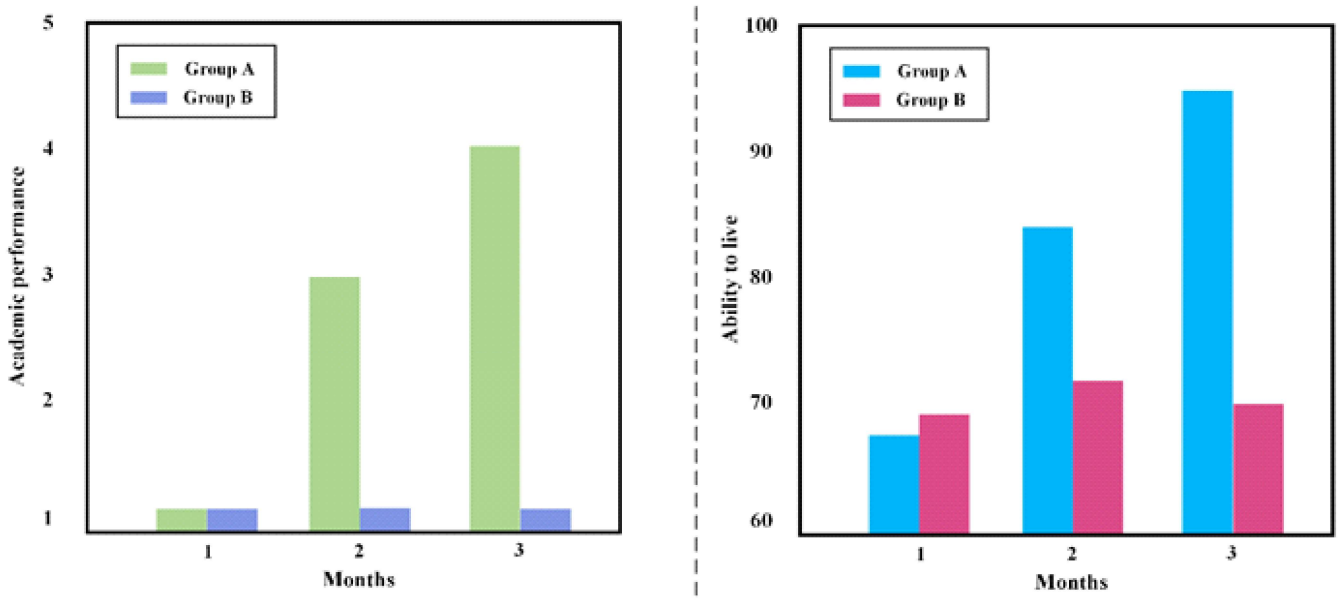

Figure 3. Comparison of Academic Performance and Life Skills of the Two Experimental Groups after 3 Months

Through training and optimization, it accurately predicts students' needs and issues and provides corresponding guidance and support. This personalized counseling approach helps improve counselors' educational capacity, meet individual students' needs, and promote comprehensive student development.

However, there are some limitations in this study that need further improvement. First, the quality and reliability of data are crucial to the model's performance. This research needs to pay more attention to quality control and accuracy during data collection to enhance the stability and reliability of the model. Second, the interpretability of the model is also a challenge. In practical applications, counselors need to understand the model's decision-making process and recommendations. Therefore, further research on how to explain and interpret the model's decisions is necessary. Additionally, the model's generalization and adaptability need further improvement to meet the educational demands of different schools, groups, and scenarios.

In conclusion, establishing a model to enhance the educational capacity of counselors based on neural network algorithms is a promising research direction. By continuously optimizing the steps of data collection and preparation, feature extraction and selection, network structure design, and model training and optimization, the model's performance and adaptability can be further improved. Solving problems related to data quality, interpretability, and generalization are also crucial for future research to achieve better application and promotion of the model for enhancing counselors' educational capacity.

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