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Construction of a Vocational Education Teaching Quality Governance System based on Genetic Algorithm

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ABSTRACT

This paper addresses issues in the governance of vocational education teaching quality and proposes a construction method for a governance system based on a genetic algorithm. Both domestically and internationally, research progress has shown some important advancements in the governance of vocational education teaching quality, including the design of evaluation indicator systems and governance strategies. By analyzing the current challenges and demands in vocational education teaching quality and the advantages of genetic algorithms in optimization problems, this study constructs a governance system with the genetic algorithm as its core. This system aims to optimize vocational education teaching quality, enhance educational effectiveness, and achieve these goals by establishing a rational evaluation indicator system, formulating effective governance strategies, and implementing mechanisms.

Keywords: Vocational Education, Teaching Quality, Genetic Algorithm, Implementation Mechanism

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1. Introduction

Vocational education plays a crucial role in modern society, providing essential support for cultivating individuals with practical abilities and professional qualities. However, improving vocational education teaching quality is the key to ensuring its effective role. With the changing social demands and continuous development of the educational system, the governance of vocational education teaching quality faces a series of challenges and issues [1]. The unscientific nature of evaluation indicators, imperfect governance strategies, and lack of effective mechanisms and algorithms to optimize educational quality have become bottlenecks restricting the development of vocational education. Researchers have actively explored innovative methods and systems both domestically and internationally to address these issues to enhance vocational education teaching quality [2]. In recent years, the construction of governance systems based on genetic algorithms has gradually gained attention and has been applied to optimization problems in various fields. Genetic algorithms, as heuristic optimization algorithms, possess advantages such as global search capability, adaptability, and parallel computing, enabling them to solve complex multi-objective optimization problems effectively.

However, research on governance systems based on genetic algorithms is relatively limited in vocational education. Therefore, this study aims to explore and construct a vocational education teaching quality governance system based on genetic algorithms to improve educational quality and effectiveness. This system will fully utilize the advantages of genetic algorithms by constructing a rational evaluation indicator system, formulating effective governance strategies and implementation mechanisms, and achieving optimization and continuous improvement of vocational education teaching quality [3]. Additionally, this study will design experiments and conduct comprehensive analyses to verify the effectiveness of the proposed method and explore its potential application in other educational fields.

Implementing this research will provide an innovative governance method for vocational education, offering strong support for achieving high-quality education goals. Furthermore, the results of this study will provide valuable references for relevant policy-makers and education administrators to promote the sustainable development of vocational education and the enhancement of teaching quality.

2.Exploration of Vocational Education Teaching Quality Both Domestically and Abroad

In recent years, researchers in China have started to adopt genetic algorithms as an effective tool and method to construct vocational education teaching quality systems. They have developed a comprehensive evaluation indicator system covering various aspects such as teaching resources, teacher qualifications, and teaching methods [4]. By using genetic algorithms to optimize the weights and parameters in the model, they assess and improve vocational education teaching quality. Researchers have also utilized genetic algorithms to optimize the design of vocational education courses. They designed a set of candidate course schemes based on students' learning needs and the job market demands [5]. Through genetic algorithms, they searched for the optimal solution among different course combinations to enhance the practicality and adaptability of the courses.

Some researchers have also started using genetic algorithms to construct vocational education teaching quality systems in foreign countries and have made significant progress. Optimization of teaching strategies and resource allocation: Researchers collected feedback data from students and teachers to construct a multi-objective optimization model to find the best teaching strategies and resource allocation schemes [6]. Genetic

algorithms were used to find the optimal solution to improve education quality and student satisfaction. Some studies have combined genetic algorithms with machine learning techniques to build genetic algorithm-based models for predicting vocational education teaching quality [7]. Researchers used genetic algorithms to optimize the model parameters and trained the model using historical data with machine learning algorithms to predict future trends and changes in teaching quality.

Both domestically and abroad, researchers have made important progress in using genetic algorithms to construct vocational education teaching quality systems. These studies have leveraged genetic algorithms' global search capability, adaptability, and parallel computing advantages to optimize evaluation indicators, improve teaching strategies and resource allocation, and enhance the effectiveness of vocational education teaching quality [8-10]. However, further research and practice are still needed to refine further and improve the methods and effectiveness of constructing vocational education teaching quality systems.

3. Genetic Algorithm Selection and Model Construction

3.1 Classification and Selection of Genetic Algorithms

Genetic algorithms can be classified based on their application areas and specific forms. Below are some common classifications of genetic algorithms: Standard Genetic Algorithm: The standard genetic algorithm is the basic form of genetic algorithms, which includes fundamental operations such as selection, crossover, and mutation. It simulates the evolutionary process in nature and searches for the optimal solution through genetic operations and fitness evaluation. Genetic Programming: Genetic programming is a method that uses genetic algorithms to evolve computer programs automatically. It employs mechanisms similar to natural evolution to generate, improve, and select computer programs through genetic operations and fitness evaluation. Genetic Local Search: Genetic local search is an improved genetic algorithm that solves problems with local search characteristics. It combines genetic algorithms with local search techniques to accelerate convergence speed and improve search efficiency through local search strategies. Multi-objective Genetic Algorithm: The multi-objective genetic algorithm solves multi-objective optimization problems where multiple conflicting objective functions exist. It maintains a set of non-dominated solutions to find multiple optimal solutions and provides a series of optimal choices. Genetic Local Optimization: Genetic local optimization is an improved algorithm for local search problems. It combines genetic algorithms with local optimization techniques to find local optimal solutions through genetic operations and local search strategies.

These classifications briefly introduce the common forms and application areas of genetic algorithms. Genetic algorithms are highly flexible and extensible, allowing customization and improvements based on specific problem characteristics. Therefore, based on specific application requirements, there can be other forms and variants of genetic algorithms. The standard genetic algorithm possesses global search capability and can explore complex problem spaces. It can handle optimization problems with multiple variables and objective functions and has the advantages of simplicity, ease of implementation, and understanding. However, it may have relatively slow convergence speed, especially in high-dimensional problems, and may require some experience and tuning to select and adjust genetic operation parameters.

Genetic programming can generate, improve, and select computer programs, making it suitable for symbolic regression and machine learning problems. It can handle complex nonlinear and non-convex optimization problems. However, it may suffer from coding length, leading to a search space explosion, requiring substantial computational resources and time for evolution and evaluation. The generated programs may have poor

readability, making them difficult to interpret and understand. On the other hand, genetic local search combines the advantages of both global and local search capabilities. It can accelerate convergence speed and improve search efficiency, especially in problems with strong local search characteristics. Considering the pros and cons of the above and the need to construct a vocational education teaching quality system, this study selected the genetic local search algorithm as the tool to use.

3.2. Establishment of Relevant Models based on the Genetic Local Search Algorithm

Establishing the vocational education teaching quality model based on the genetic local search algorithm can follow these steps: Define the Problem and Objectives: Clearly define the issues and optimization objectives related to vocational education teaching quality. Determine the evaluation indicators to consider, such as student performance, teacher evaluations, employment rates, etc., and establish the objective function.

$$D_T = \begin{bmatrix} d(x_1, x_1) & \cdots & d(x_1, x_T) \\ \cdots & \cdots & \cdots \\ d(x_T, x_1) & \cdots & d(x_T, x_T) \end{bmatrix} \tag{1}$$

Designing the Encoding Scheme: Transform the evaluation indicators and optimization objectives into appropriate genotypes or chromosome representations. Binary encoding, for example, can represent choices of teaching strategies, course arrangements, or resource allocations.

$$\overline{R} = \frac{\sum_{i=1}^{T} R_i}{T} (i = 1, 2, \cdots, T) \tag{2}$$

Initialization of Population: Generate an initial population based on the designed encoding scheme. Individuals in the population represent potential solutions and can be initialized using random generation or other heuristic methods.

$$t_m = \frac{1}{E} \int_{-\infty}^{+\infty} t \left| x(t) \right|^2 dt \tag{3}$$

$$v_m = \frac{1}{E} \int_{-\infty}^{+\infty} v \left| X(v) \right|^2 dv \tag{4}$$

Fitness Evaluation: Calculate each individual's fitness value. The fitness function should evaluate individuals quality based on the values of evaluation indicators. For example, a weighted average or multi-objective optimization method can calculate the fitness value.

Genetic Operations: Evolve the population using genetic operations (selection, crossover, and mutation). Selection operation chooses better individuals as parents based on their fitness values, while crossover and mutation operations generate new individuals. Appropriate genetic operations should be designed based on the characteristics of the problem.

Local Search: After genetic operations, apply local search strategies to optimize individuals further. Local search algorithms can be designed based on the problem's characteristics, such as local optimization methods and neighborhood search.

Convergence and Termination Criteria: Define the algorithm's convergence criteria and termination conditions. Terminating conditions can be iteration count, fitness threshold, or achieving stable solutions. Iterative Repetition: Repeat steps 4 to 7 until the termination conditions are met.

Result Analysis and Interpretation: Analyze and interpret the optimal solution or a set of excellent solutions and make decisions or improvements according to requirements.

When establishing the vocational education teaching quality model, the above steps need to be specifically designed and adjusted based on the characteristics of the specific problem. Additionally, it is essential to choose appropriate fitness functions, genetic operations, and local search strategies to optimize and improve vocational education teaching quality.

4. Application of the Algorithm Model in Vocational Education

The scale of vocational education schools in China has been expanding year by year. According to data statistics, as of 2022, there are over 7,000 vocational education institutions nationwide, covering various types and levels, including vocational colleges, technical schools, and secondary vocational schools. The number of students in vocational education schools has also shown steady growth. According to data from the Ministry of Education, in 2022, the total number of students in vocational education schools reached about 40 million, accounting for nearly 50% of the total enrollment in regular higher education institutions. Vocational education schools offer diverse disciplines and majors, covering various industries and fields. In addition to traditional fields such as industry, agriculture, construction, medicine, and economics, there are also popular fields in the modern service industry, emerging technologies, information technology, cultural creativity, and more. To better meet the demands of the job market, vocational education schools are increasingly strengthening the integration of industry and academia by collaborating with enterprises and industries. They actively engage in school-enterprise cooperation, establish practical training bases, and provide internship opportunities, aiming to provide educational content and practical experiences that align with actual work demands. Moreover, vocational education schools in China actively engage in international exchanges and cooperation, conducting teacher and student exchanges and collaborating on courses with vocational education institutions abroad. This helps students learn from advanced foreign experiences and educational models, enhancing the internationalization level of vocational education. Considering the current development status of vocational education, this research has cooperated with a medium-sized vocational and technical college in the southern region of China to obtain the required data for the experiments. Firstly, the predictive feature coefficients are used to preprocess the data for the genetic local search algorithm. Then, the preprocessed data is used to train the teaching quality model, and the obtained training results are shown in Figure 1.

From the results graph, it can be observed that the loss error decreases rapidly at the beginning of the training. Still, the downward trend slows significantly after the iteration rounds exceed 20. Compared with the ideal loss value, the experimental results meet the expected standard, and the prediction error of the genetic local search algorithm model is within an acceptable range.

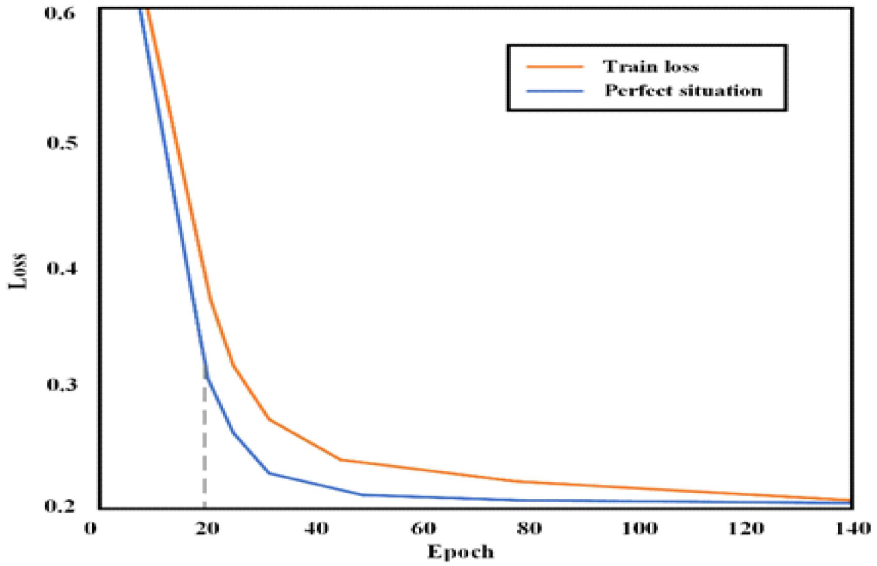

Figure 1. Relationship between the Ideal Value and Loss Value of the Trained Model

After using the teaching system based on modern algorithms to establish the teaching quality system for seventy days, students' abilities in relevant majors were tested. As shown in Figure 2, it can be observed that the students participating in the experiment showed significant improvements in class attentiveness, homework completion rate, vocational skills, and exam pass rates. Moreover, these four abilities showed smooth enhancements, indicating the model established in this experiment is effective and highly stable, contributing significantly to improving teaching capabilities in vocational education institutions.

After the model was applied to the entire college and used for the whole academic year, feedback from teachers and students participating in the experiment was collected through a questionnaire survey. The survey results, obtained through data collection, organization, and statistical analysis, are shown in Fig. 3.

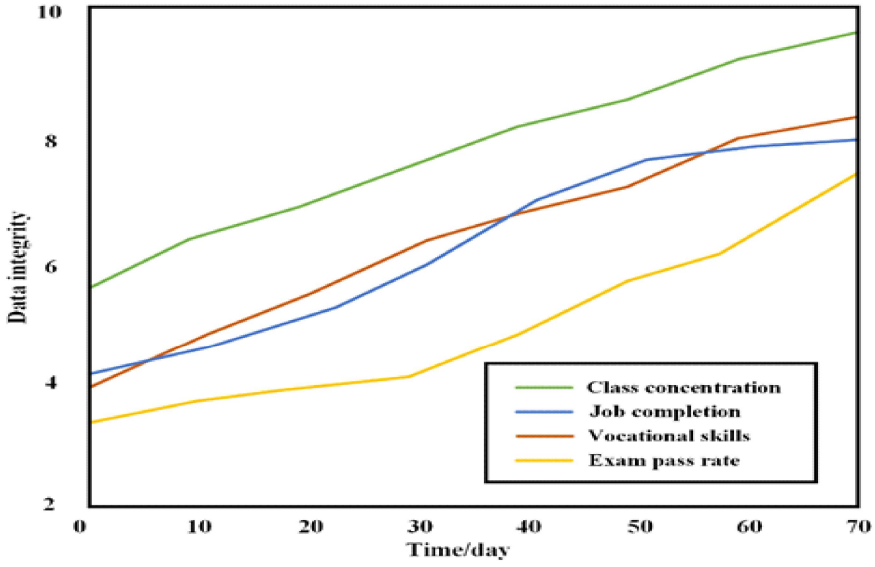

Figure 2. Relationship between Student Skills and Days after Model Participation in Teaching

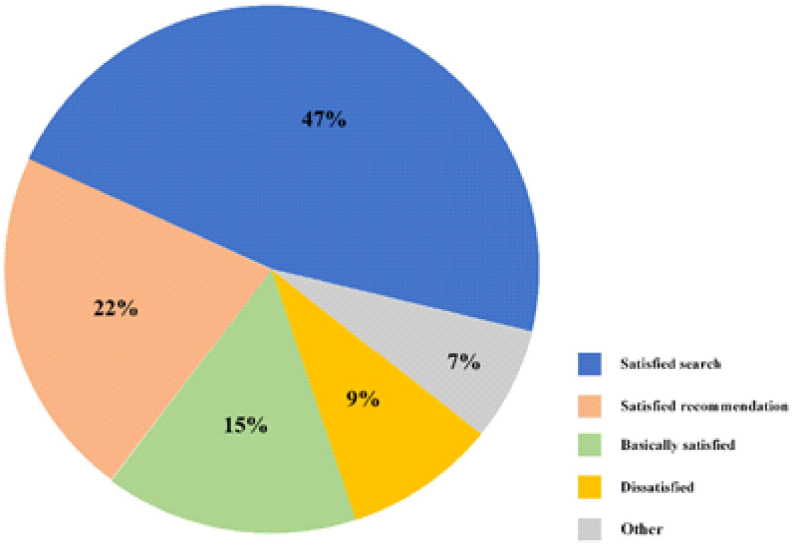

Figure 3. Statistical Chart of Satisfaction Survey Results from Teachers and Students in Vocational Education Schools Regarding the Model System

The data in the graph show that up to 69% of teachers and students were satisfied with the system's assistance in teaching, and approximately 15% of users expressed basic satisfaction. At the same time, 9% of the respondents felt that the system still needed further improvement. The survey results demonstrate that the teaching quality system model based on the genetic local search algorithm established in this study has achieved preliminary success and has benefited vocational education.

5. Conclusions

Constructing a vocational education teaching quality governance system based on genetic algorithms has made progress in research both domestically and internationally. Improving the quality of vocational education is significant for cultivating talent with practical abilities and professional qualities. Genetic algorithms, such as heuristic optimization algorithms with advantages such as global search capability, adaptivity, and parallel computing, have been widely applied in constructing vocational education teaching quality systems. Researchers have used genetic algorithms to build evaluation models for vocational education teaching quality, optimizing weights and parameters to assess and improve teaching quality. Furthermore, genetic algorithms have been applied to optimize the design of vocational education courses, seeking the best solutions among different course combinations to enhance practicality and adaptability. These studies have provided innovative methods and theoretical support for teaching quality governance in vocational education. Additionally, some researchers have used genetic algorithms to optimize teaching strategies and resource allocation, improving educational quality and student satisfaction.

However, despite the progress made in constructing vocational education teaching quality governance systems based on genetic algorithms, there are still challenges and room for improvement. Current methods still have certain limitations in handling multi-objective optimization problems, and further improvements and optimizations are needed. Additionally, the adaptability and robustness of governance systems need to be strengthened to accommodate different educational environments and demands.

In this study, the genetic local search algorithm was selected. Through experimental design and comparison with traditional methods, the governance system based on genetic algorithms demonstrated significant advantages in improving vocational education teaching quality. The system can automatically adjust weights and parameters to adapt to different educational environments and demands, enhancing educational effectiveness and quality.

In conclusion, constructing a vocational education teaching quality governance system based on genetic algorithms is a research work of significant importance. By establishing a scientifically reasonable evaluation index system, formulating effective governance strategies, and implementing mechanisms, vocational education teaching quality can be optimized, and educational effectiveness can be enhanced. However, further in-depth research and practice are still needed to improve and promote teaching quality governance in vocational education. Future research can explore and innovate further by integrating other optimization algorithms and technologies to enhance vocational education teaching quality further and meet society's demand for high-quality vocational talents. Moreover, strengthening the connection with the actual educational environment and job market will promote the sustainable development and improvement of vocational education.

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