Evaluation of teaching quality in higher vocational colleges based on quantum behaviour particle swarm optimization

Wanzhi Ma, Zhangcheng Yang
Dept. of Education and Cultural Information Development, Woosuk University, South Korea

Corresponding author and e-mail: Wanzhi Ma, mawz79email@189.cn

Abstract. The implementation of teaching evaluation comprehensive evaluation system and effective management on teaching quality can scientifically manage the development of teachers' teaching activities. At present, the teaching quality evaluation of teachers in higher vocational colleges has not yet realized algorithm operation based on quantum behavior particle swarm optimization. Therefore, it is necessary to study the teaching quality evaluation system consistent with the characteristics of higher vocational colleges. Quantum particle swarm optimization can construct a system model that can evaluate the quality of teaching. The system includes various functions like management and evaluation, which can be closely combined with the actual needs of each college. User name and password can effectively improve the security performance of the system. Convenient and fast database management operation, as well as intelligent and friendly database management interface, can ensure the timeliness and accuracy of query results. Research shows that, based on the practical application of quantum behavior particle swarm optimization in the field of teaching quality evaluation, the means of teaching evaluation are more scientific.

1. Introduction
The perfection of teaching and evaluation of teaching quality is the main way to achieve the teaching objectives in school education. Teaching quality should be clarified, so that the school education management department can scientifically understand the teaching progress of the designated courses, comprehensively master the teaching situation of school teachers, and formulate scientific implementation plans and management measures for the effective improvement of teachers' teaching quality in the future. The level of talents cultivated by schools is closely related to the teaching ability of teachers which is difficult and complicated to evaluate. At present, the teaching quality evaluation system used in many higher vocational colleges and the internal evaluation methods need to collect massive data in the early stage and dig in the later stage, and follow specific decision rules. In the process of data processing, it is easy to be affected by problems such as early data collection and arrangement, late data analysis and application, evaluation methods and human factors. Therefore, it is of great practical significance for the research on the evaluation of teaching quality in higher vocational colleges to explore the corresponding relationship between the input and output of the evaluation system and to build a mathematical model with realistic explanatory power and predictive power. Among today's popular intelligent algorithm of random search, Quantum-behaved Particle Swarm Optimization (QPSO) is more feasible in optimization due to its faster convergence speed,
stronger optimization ability and less control parameters [1]. Research on teaching quality evaluation in higher vocational colleges based on quantum behavior particle swarm optimization can promote the organic combination of practical value and academic significance, so as to realize the optimization and evaluation of teaching quality of teachers in higher vocational colleges.

2. Start of the art
In 1995, the American electrical engineer Russell Eberhart and social psychologist James Kennedy inspired by birds group. They combined with the research result of biologist Frank Heppner who is from the University of Rhode Island and put forward Particle Swarm Optimization which simulated birds swarm behavior [2]. As a result of few control parameters, simple calculation and easy implementation, many scholars in related fields at home and abroad began to focus on and actively study this algorithm from the aspects of algorithm improvement, analysis and application. Firstly, in order to compare the performance difference between PSO and genetic algorithm, Kennedy and Eberhart [3] improved and optimized the structure of binary PSO, so that it could be applied in neural network. Secondly, in order to optimize the convergence effect of the algorithm, Shi and Eberhart [4] implanted the inertia weight port into the velocity term of the PSO, and realized the dynamic adjustment of the inertia weight of the evolutionary equation by balancing the convergence speed and the global nature, which is also known as the Standard PSO (SPSO). Shi and Eberhart [5] then proposed a linear reduction method of the inertia weight in the running time of the algorithm, and a method of dynamically adjusting the inertia weight in the fuzzy system. Clerc [6] embedded the contraction factor into the evolution equation to ensure the convergence of the algorithm and ease the restriction imposed by the system on the convergence speed. At present, some scholars have carried out detailed analysis on this issue with the assistance of algebraic method, and given specific suggestions for guiding parameter selection.

Jin peng (2018) [7], a Chinese scholar, introduced the mathematical model and basic principle of QPSO in detail in the paper Research on Improved Quantum-behavior Particle Swarm Optimization and Its Application in Optimization Problems, in which he summarized the advantages and disadvantages of performance of this algorithm, and based on this, he optimized and improved QPSO according to relevant theories.

3. Methodology
3.1. General process of teaching quality evaluation system
The main types of teaching quality evaluation system in higher vocational colleges are teaching information management and teaching quality evaluation. Teaching information management mainly manages the teaching information of teachers, while the teaching quality evaluation mainly evaluates the teaching quality of teachers according to the regulations and teaching requirements of higher vocational colleges.

The academic department is responsible for transmitting the information of hired teachers and course information to the administrators of the academic department, who will conduct statistical analysis on this information, form the basic information table of teachers, and feed back to the academic department. This is the flow of teaching information management of teachers [9], as shown in figure 1.
The academic department is responsible for teaching and basic information of teachers and students, which is transmitted to the administrator of the academic department who conducts statistical analysis on the information and corresponding relations are gained. The corresponding relations are combined with the evaluation content table made by the academic department and form the evaluation result feedback in the part of evaluators. Then it is transmitted to the administrator of the academic department and the teacher being evaluated. And teachers who are privileged to have the right to login the system can automatically check the evaluation result. This is the process of teaching quality evaluation [10], as shown in figure 2.

3.2. Introductions to particle swarm optimization and quantum-behavior particle swarm optimization

Particle swarm optimization, which is similar to genetic algorithms, is an optimization tool based on iterative evolutionary computing technology invented by Russell Eberhart, an American electrical engineer, and James Kennedy, a social psychologist, on the predation behavior of birds. [11] Because PSO can obtain the optimal value through iterative search without the mutation and cross mutation of genetic algorithm, it can generate the required intra-group random solution when the system is initialized. Like other evolutionary algorithms, PSO includes the concepts of "evolution" and "community". However, the difference between PSO and other evolutionary algorithms is that the algorithm is not open to individuals. The velocity and weight of each particle can compose the search space of each particle, and the flight dynamics and flight experience of individuals and groups can be used as the adjustment index of flight speed.

Set vectors:
\[ X = (X, X_{11}, \ldots, X_{12}, X_{in}) \] represents the current position of particle i;
\( V = (V_1, V_2, \ldots, V_m) \) represents the current flight speed of particle \( i \);

\( P = (P_1, P_2, \ldots, P_m) \) represents the current optimal position of the \( i \)th particle. According to the maximization of the objective function, the optimal position of the particle can be determined by the following formula:

\[
P_i(t+1) = \begin{cases} 
  P_i(t); & \text{if} \ (X_i(t+i) \leq f(P_i(t))) \\
  X_i(t+i); & \text{if} \ (X_i(t+i) > f(P_i(t)))
\end{cases}
\]

To solve the optimization problem with the assistance of PSO, it is particularly important to clarify the coding and fitness function. The application of real code is the inherent advantage of PSO, which is different from genetic algorithm based on binary code, whose genetic operation is mainly based on real numbers. For example, to solve the problem \( f(x) = x_1^2 + x_2^2 + x_3^2 \), PSO can directly encode particles as \((x_1, x_2, x_3)\), thus obtaining fitness function \( f(x) \), and carrying out iterative optimization accordingly. When the process has the minimum error or the maximum number of cycles, the optimization operation will automatically terminate.

The classic PSO, also called Quantum-behaved Particle Swarm Optimization (QPSO) is invented based on the PSO. It updates the means of location evolution of particles to make the location of each particle the best locally and globally. The QPSO algorithm is applied to calculate the particle swarm movement, which needs to comply with the following three formulas [12]:

\[
\text{mbest}(t+1) = \frac{1}{M} \sum_{i=1}^{M} P_i(t) = \left( \frac{1}{M} \sum_{i=1}^{M} P_{i1}(t), \frac{1}{M} \sum_{i=1}^{M} P_{i2}(t), \ldots, \frac{1}{M} \sum_{i=1}^{M} P_{im}(t) \right)
\]

\[
PP_i(t+1) = f_{ij}(t+1) \times P_i(t) + (1 - f_{ij}(t+1)) \times P_{ij}(t)
\]

\[
X_i(t+1) = PP_i(t+1) + Rand(t+1) \times a(t+1) \times |\text{mbest}(t+1) - X_i(t)| \times \ln\left( \frac{1}{\mu_0(t+1)} \right)
\]

3.3. The frame design of QPSO's application to the evaluation system of teaching quality

As shown in figure 3, the application of QPSO in the frame design of the teaching quality evaluation system needs to go through the following process [13].
With the help of the hierarchical diagram, the relationship between the various modules of the system can be clearly demonstrated. After entering the system, the particle swarm needs to be initialized and fitness evaluation is obtained. Based on the fitness position of the individual, the system will calculate the fitness position of the individual, based on which, the speed and position of the updated particles are updated. If the termination condition is not met, it will loop indefinitely according to the original process until the termination condition is met. It can be seen that although the teaching information management module and the teaching effect evaluation module in the system are independent of each other, there are closely linked database access behaviors. In general, the following modules can be further divided according to the two modules of the system.

First, the teaching information management module can be classified into four modules, including information entry module, information modification module, information query module and information deletion module.

Second, the teaching effect evaluation module can be divided into six modules, including evaluation relation management module, evaluation content management module, student evaluation module, supervisor evaluation module, school leader evaluation module and evaluation grade management module.

Each module has the following functions.

The basic function of information input module is to systematically input the basic teaching information of teachers.

The basic function of the information modification module is to modify teachers’ information according to actual changes.
The basic function of the module of information query is to inquiry teachers’ information with some keywords.

Cleaning up invalid teachers’ information in time is the basic function of the information deletion module.

The basic function of the module of evaluation relationship is to clarify the relationship between teachers and students, teachers and supervisors and teachers and school leaders.

It is the basic function of evaluation content management module to change evaluation content according to the actual situation and college documents.

It is the basic function of student evaluation module to establish student evaluation matrix and define student evaluation weight.

The basic function of the supervisor evaluation module is to establish the supervisors’ evaluation matrix and define the supervisory evaluation weight.

It is the basic function of the module of the school leaders’ evaluation to establish the evaluation matrix of the school leaders and define the evaluation weight of school leaders.

The basic function of evaluation grade management module is to announce the evaluation results of teachers to all the teachers and students of the school and report the results to the leaders of the school.

The functional structure of teaching information management and evaluation system is shown in figure 4 [14].

![Figure 4. Function Structure of the System.](image)

3.4. The detailed structure of QPSO applied to teaching quality evaluation system

Developing information application system is the core and key of database construction technology. In the established application environment, the main research direction of developing database design software is to clarify user needs and information processing requirements and promote the system design and application of organic combination. The complex information structure and application environment make manual patchwork a common method in database design. The application of this method depends on the designer's design level and experience. Due to the lack of scientific project and
theoretical support, it is difficult to ensure the software quality and reliability. The system maintenance cost will inevitably increase as a result of frequent problems in database operation.

First, analyze the data. The identification, development and organization of data, as well as filtering, are related to the physical and logical structure of data analysis. By analyzing and classifying user information, the data model can be directly transformed into database. Entities, entity attributes and entity relationships in modeling objects define modeling techniques to some extent. Users can only determine the nature of the entity relationship by determining the attributes of a single entity. In order to define complete description and usage requirements for modeling objects, it is necessary to identify demands of entity usage application, process attributes, indexes, primary keys, the organization means of attributes and the data types of entity attributes. The high-level description needs to further determine the extended attributes of all entities, including initial values, format, length, validation rules, and editing style. For the specific organization classification of entity nature, it is necessary to preliminarily determine the classification model of abstract layer, classify different types of data, and systematically analyze and observe the data with the assistance of physical package.

Second, design the database. Database design should consider the following items:

1. The database should be created according to the application of the database.
2. It is necessary to comply with specific database design regulations in order to avoid errors occurring in the designation of database.
3. Protect data integrity.
4. Ensure that the database is able to maintain system user permission security;
5. The hardware configuration and size of the database should be measured and Microsoft SQL Server 2000 is used to meet the performance improvement requirements of the application.
6. Maintain the database regularly.

Figure 5 is the E-R database of teaching information management and evaluation system [15].

![E-R Diagram of Database](image)

The operation basis of PSO is to following the basic framework of evolution strategy on the premise of keeping the basic evolutionary equation unchanged. The improved QPSO, although the process is more complex, the algorithm performance has been improved. Due to the optimization of quantum particle swarm, the velocity vector embedded in the internal evolution equation of...
independent evolutionary search strategy needs fewer parameters to control, so it has a simpler evolution form. The analysis and design of the system ER diagram centering on the functional modules of the demand analysis system can meet the planning requirements of the system database, and describe the overall design concept of the database structure used by the system in detail, so as to make sufficient preparation for the database development.

4. Discussion
Information technology is developing at an unprecedented speed. As a result, there are more and more software products in the market and its application areas are broadened. In order to gain more market share, software developers must take quality as the primary goal of their products.

4.1. Software testing
Software is designed and coded on the basis of market research, and then the source code is tested, during which, the deficiencies of the software will gradually be exposed. Timely detection of the problems in the software facilitates errors correction and avoiding economic losses. Since there is no better way to verify whether the program meets the requirements, software testing is still a commonly used method.

The main role of testing software is to figure out the programming errors that affect program operation. There will be a majority of problems during actual software developing. The main purpose of testing is to find out and solve these problems so as to continue to develop the software.

During the process of testing the software, it is necessary to test both the input data and the output data. In fact, testing output data is to test whether the expected effect can be achieved. It is advantageous for the next-step development of software to find out the gap of obtained result and the expected effect. Through the above process, you can get the results obtained in the testing process and the expected data results to constitute a test case.

4.2. The system test of QPSO applied to the teaching quality evaluation system
According to different angles, tests can be divided into different types. It can be divided into manual and automatic tests according to whether the test is manual or not. According to the source code of the program, it can be divided into unit and functional tests. According to the test theory, it can be divided into black box and white box tests.

The black box testing is conducted by the method of causal diagram. In the process of testing the program, the corresponding combination of various conditions and factors should be taken into consideration. Since there are countless combinations theoretically, relevant factors should be considered to find the best combination for test cases, and finally the test purpose should be achieved through causal diagram. This method is written through the natural language design requirements to find out the cause and effect relationship in the program, and then transfer it into a decision table by changing the diagram. Figure 6 is the basic form of a causal diagram.

![Figure 6. Basic Graphical Symbols of the Causal Diagram.](image)
The testing process: First, open the interface and fill in teacher’s ID and password according to the system requirements. The system will verify whether the teacher data is in accordance with the requirements. If the input information is proved, relevant data can be queried. If the teacher’s information is not found, the system will prompt the teacher’s information is not in the system, and the teacher can be evaluated in the evaluation system. If the input information is incorrect, such as teacher’s ID is wrong, the tester can’t go to the interface or operate and the system will prompt a series of error message.

There are three situations according to the above conclusions.
Here are the reasons. First, the ID information of the teacher matches information in the system, indicating that the teacher is in the system. Second, the teacher is the lecturer in the system. Third, the teacher has evaluation information in the system.

Results:
50. Enter the system to query results and data.
51. Go to the evaluation system.
52. The teacher was not found and hint correspondent information.
53. Evaluation information for the teacher was not found.
The causal diagram is shown in figure 7.

5. Conclusions
This research aims to study the teaching quality evaluation system in line with the characteristics of higher vocational colleges through the algorithm calculation of quantum behavior particle swarm algorithm, and open up a new way for higher vocational teachers' teaching quality evaluation. On this basis, a new method for evaluating teaching quality of vocational education in colleges and universities has been established, and a teaching quality evaluation guidance program based on quantum behavior has been gradually formed. The implementation of these schemes facilitates the improvement of teaching quality and teaching management level. In practice, object programming computations helps to find the right breakthrough point to solve the problem, thus increasing the chances of reusing computations. The optimization of particle swarm to measure quantum behavior can not only adjust the parameter values within the appropriate range, but also produce the maximum and minimum values, so that it is easier to adjust the parameters. The interface of the system evaluation management system is similar to the computer webpage that is often used. This system covers the information management system in the teaching process and the functions related to the evaluation of teaching quality in daily use. At the same time, this system can provide corresponding
functions on the basis of the actual needs of colleges and universities. When logging into the system, the user's basic information should be identified, so it has high security performance. The interface design of the management database system is humanized, which is beneficial to find information quickly and accurately. The study has the following limitations: the article has done research on the theory and framework of the teaching evaluation system through QPSO. The research process only explained the data source and there is no data display. The research has the following limitations: This article uses QPSO to study the theory and framework of the teaching evaluation system. The research process only explained the data source, no data was displayed. It is suggested that follow-up research hopes to further improve the integrity, completeness and operability of this evaluation system through data verification research.

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