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# The Research on Comprehensive Evaluation System of Teachers' Quality Construction in Ethnic Minority Areas

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Abstract. The theory and method of fuzzy mathematics has been utilized to evaluate comprehensively the status of teachers' quality construction. Membership function of factors are designed based on the foundation of multi-level model, primary factor set and secondary factor set indicator system together with the weight allocation. According to the actual data of each project in each region, after normalization processing and quantitative calculation, the sub-project membership degrees are calculated. The multi-level evaluation matrixes are constructed based on the membership degrees to calculate the multi-level evaluation results and obtain the comprehensive evaluation result finally. The experiment results prove the validity and advantage of the proposed method compared with the traditional methods. A comprehensive evaluation system of teachers' quality construction in ethnic minority areas has been built based on the method proposed in this paper which has the ability to evaluate comprehensively the status of junior high school teachers' quality construction in different ethnic minority areas.

Keywords: comprehensive evaluation, ethnic minority areas, fuzzy mathematics, teachers' quality construction

## 1 Introduction

Education is the basic of a one-hundred year strategy of a nation. Insisting on the priority development of education is the driving force to promote rapid development of social economy and harmonious development of society. China's education has developed rapidly and has made remarkable achievements. However, restricted by historical, social and natural conditions, the development of social economy in many ethnic minority areas is backward and the development of education is considerably short to other areas which is not only the short board of China's education development but also the short board of rapid development of social economy in ethnic minority areas.

The status of teachers' quality construction in ethnic minority areas refers to the overall quality and teaching level of teachers in ethnic areas that are influenced by synthetic measures and Comprehensive factors [1-2]. To make a reasonable evaluation of the status of teachers' quality construction in ethnic areas is the basis of further enhancement of the teachers' quality construction. In the various stages of education, the obligation education is in the top priority, and the junior middle school education plays an important role in the process, which needs to be paid additional attention and research. During the education in school, the main and key part of education implementation is teachers. However, the relatively tough environment and relatively weak education resources in ethnic minority areas are less attractive to excellent teachers which makes teachers become the key to accelerate the development of education in ethnic regions. Making a comprehensive evaluation on the quality construction of the teachers in ethnic regions helps a lot in balancing education resource allocation and promoting the development of the education [3]. It is of great significance for the research on further strengthen the quality construction of the teachers by using the fuzzy mathematics theory to make the comprehensive evaluation [4-5].

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The major methods mainly rely on the data collected by questionnaire and statistical survey together with the existing evaluation systems. The widely used evaluation systems contain the Objective Assessment Model that utilize the basic qualities of teachers including professional competence and work performance to evaluate the quality [6], the Developmental Evaluation Model which encourage development and active learning [7] and the "Input, Course and Output" Model that design the indexes of each stage to evaluate the quality of education, reflecting the quality of teachers [8]. In this paper, we use the Comprehensive Evaluation Method [9] to evaluate the teachers' quality.

Comprehensive Evaluation Method refers to the method of evaluating multiple evaluation units with multiple indicators, the main idea of which is to convert multiple indicators into an indicator that reflects the overall situation. Commonly used comprehensive evaluation methods include the principal component analysis [10], data envelopment analysis [11], fuzzy evaluation method [12-14]. Among methods mentioned before, fuzzy mathematics is a mathematical theory and method to study and handle fuzzy phenomena. It is widely used in science and technology, economic development and sociology and has attracted extensive attention from researchers in mathematics, information technology, system technology, and computer & automation control technology. Fuzzy mathematics is a new discipline which is developing rapidly with broad application prospect.

The common methods utilizing to evaluate the teachers' quality focus on qualitative analysis and are lack of comprehensive analysis. In order to make a comprehensive evaluation on the quality construction of the teachers accurately and effectively, this paper propose appropriate membership function and quantitative formula based on fuzzy evaluation model after investigating the comprehensive evaluation system of teachers' quality construction in ethnic minority areas to improve the accuracy of comprehensive evaluation and study the variation trend of teachers' quality construction condition through the variation trend of the related influencing factors at the same time.

In the remainder of the paper, we briefly mention the related work about the comprehensive evaluation system and some methods based on the fuzzy mathematics in Section 2. Thereafter, in Section 3, we describe the proposed fuzzy evaluation model in details. The function, structure and realization of the system based on fuzzy evaluation model is introduced in Section 4. Section 5 presents the simulation results of three ethnic minority areas and compares them with two other existing methods. Finally, we draw a conclusion of this paper and present the future research in Section 6.

## 2 Related Work

In order to understand a thing comprehensively, it is necessary to make a comprehensive evaluation. Therefore, different comprehensive evaluation systems for different objects have been designed and proposed. Some researchers detailed the evaluation indexes combining with practice data, for example, Li [15] proposed a conception of quality evaluation system for sign language service provided by railway passenger department based on improving passenger service quality of railway department and combining with current information technology. The paper also elaborated and analyzed the implementation process and provided a referential evaluation mode for improving the quality of railway passenger service in the market economy. According to the actual demand of the teaching management department, Shen and Zan [16] proposed a comprehensive evaluation model of curriculum in three dimensions, designed a uniform index scoring algorithm and determined the weight of each evaluation index using the analytic hierarchy process method, with the help of which, the researchers implemented the secondary development of the comprehensive evaluation function of curriculum based on the existing framework of Moodle system and the database structure. Performance of the system indicated that the evaluation result can accurately and objectively reflect the status of curriculum construction and the service condition, helping the teaching management department to realize the process supervision. Some other researchers utilizing the mathematics to improve the evaluation model, such as that Hao et al. [17] proposed an evaluation system for online courses utilizing the fuzzy mathematics method and introduced the design philosophy and basic function of the web-based evaluation platform. Experiment results showed that the conclusions and suggestions obtained by the system have strong practicability. Considering the situation of the railway ministry. On the basis of the teaching practice in Hanzhong vocational and technical college, Wang [13] took a research on the application of fuzzy mathematic theory in teaching appraisement system and had in-depth analysis and design of the fuzzy evaluation model based on fuzzy mathematics. The researchers also implemented a teaching evaluation system for

Hanzhong vocational and technical college by adopting the B/S model structure system and JSP/Servlet webpage development technology that is stable, simple and easy to use, improving the teaching evaluation efficiency and facilitating the teaching management.

On the other side, multiple evaluation methods can be used in the comprehensive evaluation system, among which the comprehensive evaluation system based on fuzzy evaluation method is widely used because of its small calculation and high precision. Some researchers focus on improving the existing methods. On the basis of the method and theory of fuzzy mathematics together with the students' appraisal, Gong and Zhang [4] made a comprehensive evaluation about the effect of classroom teaching. This method quantifies the qualitative description, eliminating the effects of human factors and making the result more practical. Zhou [12] made a scientific, quantitative and comprehensive evaluation of the teaching work of physical education teachers by using the theory of fuzzy mathematics, realizing the standardization and unification of physical education teaching and making physical education more scientific and reasonable. Some studies are made to refine the evaluation model. Based on the teaching requirement from market-oriented economy, Bao et al. [5] made a research on the evaluation index of teaching quality in universities, discussed the application of fuzzy evaluation method in teaching quality evaluation and constructed the fuzzy comprehensive evaluation model of teaching quality in universities, providing the basis for teaching quality management in universities.

According to the structure and application of different comprehensive evaluation system, this paper make a research on the related algorithms of fuzzy evaluation and proposes a comprehensive evaluation system of teachers' quality construction in ethnic minority areas based on fuzzy evaluation. The system make comprehensive evaluation about teachers' quality in ethnic regions. The analysis results of the actual cases show that the comprehensive evaluation system presented in this paper has better performance.

## 3 The Fuzzy Evaluation Model

Fuzzy comprehensive evaluation is to make a comprehensive evaluation or decision based on a certain target or standard, considering the influence of various factors in a fuzzy environment. The quality of teachers in ethnic areas cannot be simply classified into good or bad on account of that the quality comprehensive evaluation of teachers in ethnic minority areas is a nonlinear system and is a multi-faceted problem. The whole evaluation process is very fuzzy, so it is feasible to use fuzzy mathematical for modeling the comprehensive evaluation. The concrete process of fuzzy evaluation is described below.

### 3.1 Factor Set Establishment

Multiply model has been used to establish the factor set, it is divided into two levels according to the expertise. The factors that directly affect the quality construction of teachers in ethnic areas form the primary factor set. The primary factor set consists of three factors, policy support, economic and social infrastructure and talent resource foundation.

Average public finance budget education expenses of ordinary junior middle school students, average public finance budget education expenses growth rate of ordinary junior middle school students and average building area of junior middle school students corresponding to the current investment, future trend and the past accumulation are the secondary factors of policy support, reflecting the extent of policy support.

Per capital gross regional product, growth rate of per capital gross regional product and per capita public library reserves corresponding to the current developments, future trend and past accumulation of facilities are the secondary factors of economic and social infrastructure, reflecting the state of the economic and social foundation.

Average number of higher education students per 100,000 people, ordinary college student-staff ratio and number of new publications per 10,000 people corresponding to the number of training talent resource, quality condition and current situation of talent resource and culture are the secondary factors of talent resource foundation, reflecting the situation of talent resource.

Variable U refers to the aggregate factor set, satisfying that

$$U = \{U_1, U_2, U_3\} .$$

U1 refers to the factor set of policy support, U2 refers to the factor set of economic and social infrastructure and U3 refers to the factor set of talent resource foundation, satisfying that

$$U_1 = \{u_{11}, u_{12}, u_{13}\},\ U_2 = \{u_{21}, u_{22}, u_{23}\},\ U_3 = \{u_{31}, u_{32}, u_{33}\}.$$

The parameters are described as follows, u11 refers to the average public finance budget education expenses of ordinary junior middle school students, u12 refers to the average public finance budget education expenses growth rate of ordinary junior middle school students, u13 refers to the average building area of junior middle school students.

u21 refers to the per capital gross regional product, u22 refers to the growth rate of per capital gross regional product, u23 refers to the per capita public library reserves.

u31 refers to the average number of higher education students per 100,000 people, u32 refers to the ordinary college student-staff ratio, u33 refers to the number of new publications per 10,000 people.

### 3.2 Weight Assignment

The corresponding weights are allocated according to the importance of different factors. In this paper, the weights are assigned based on the specialist evaluation method, on the basis of suggestions from some experts in the field, education managers and front- line teachers.

The ith weight corresponding to the ith primary factor Ui is λi, i can be 1, 2 or 3. The jth weight corresponding to the jth secondary factor of ith primary factor uij is wij, i can be 1, 2 or 3 and j can be 1, 2 or 3.

### 3.3 Membership Function Construction

The membership function is a mathematical tool for representing fuzzy sets. It uses the numerical value in [0, 1] instead of just using the 0 which means absolute negation or 1 which means complete affirmation to describe the ambiguous membership between elements and the fuzzy set. In the evaluation system of this paper, the corresponding relation between each factor is obvious, and can be approximated as linear function on the interval. The maximum and minimum values of each secondary factor are the homologous linear interval.

Formula (1) represents the membership function of this paper.

$$f_{ij}(x) = \begin{cases} 1, & x \geq a_{ij} \\ \dfrac{x - b_{ij}}{a_{ij} - b_{ij}}, & a_{ij} > x > b_{ij} \\ 0, & x \leq b_{ij} \end{cases}. \quad \textbf{(1)}$$

fij refers to the membership function of secondary factor uij, x can be any value between 0 and 1, the maximum and minimum values of the homologous secondary factor are aij and bij.

### 3.4 Comprehensive Evaluation

After the construction of membership function, the secondary factors can be comprehensively evaluated. The membership degree of secondary factor u(k)ij in kth region (k=1,2,⋯,N) is y(k)ij. Based on the membership degrees of secondary factor, the judgment matrix of primary factor Ui in all regions can be represented as Mi,

$$M_i = \begin{bmatrix} y_{i1}^{(1)} & y_{i1}^{(2)} & \cdots & y_{i1}^{(N)} \\ y_{i2}^{(1)} & y_{i2}^{(2)} & \cdots & y_{i2}^{(N)} \\ y_{i3}^{(1)} & y_{i3}^{(2)} & \cdots & y_{i3}^{(N)} \end{bmatrix}.$$

Combining with the weight parameter matrix of secondary factors W, wi = [wi1, wi2, wi3],

$$W = \begin{bmatrix} w_1 \\ w_2 \\ w_3 \end{bmatrix} = \begin{bmatrix} w_{11} & w_{12} & w_{13} \\ w_{21} & w_{22} & w_{23} \\ w_{31} & w_{32} & w_{33} \end{bmatrix},$$

The primary factor Ui is comprehensively evaluated based on the M(·, +) model. The evaluation result Ri is shown as below.

$$R_i = w_i \cdot M_i .$$

The evaluation result is calculated according to the weighted calculation formula, utilizing the weights of primary factors.

$$R = \sum_{i=1}^{3} \lambda_i \cdot R_i .$$

The final result appear after the normalization processing of comprehensive evaluation result R.

### 3.5 Final Evaluation Quantization

In order to get the final evaluation numerical value of teachers' quality construction in ethnic minority areas, quantizing the final evaluation, two reference groups have been introduces, the full score reference group and the average score reference group. The value of the full score reference group is set as S, while setting the value of the average score reference group as s. The quantitative formula is shown below.

$$D_k = s + (S - s)\frac{d_k - d_{N+1}}{d_0 - d_{N+1}} \quad \textbf{(2)}$$

Dk (k=1,2,…,N) represents the numerical value of teachers' quality construction in kth ethnic minority areas, dk (k=1,…,N) represents the normalized comprehensive evaluation results of teachers' quality construction in kth ethnic minority areas. d0 is the result of the full score reference group while dN+1 is the result of the average score reference group.

## 4 The Function, Structure and Realization of the System

### 4.1 The Function of the System

The function model designed for this system is shown as follows based on Java and ORACLE [18-19].

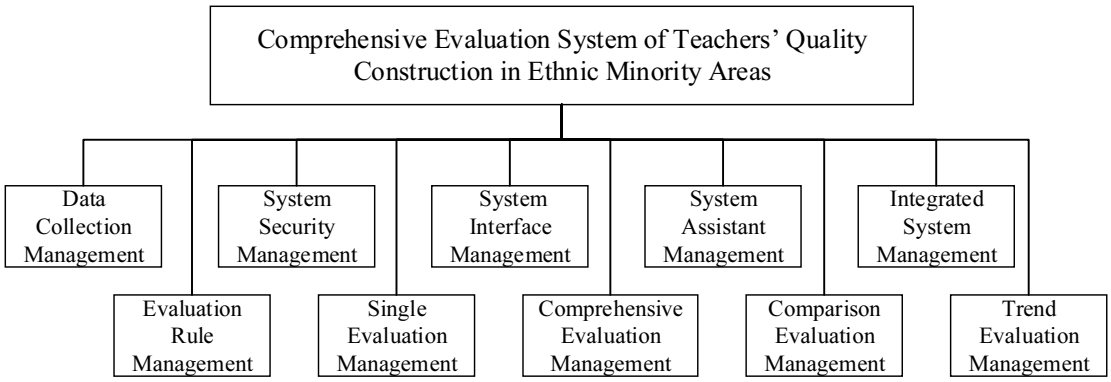


**Fig. 1.** The structure of the system function

The comprehensive evaluation system of teachers' quality construction in ethnic minority areas is based on 10 modules consisting of data acquisition management, evaluation rules management, single evaluation management, comprehensive evaluation management, comparison evaluation management, tendency evaluation management, system integrated management, system security management, system help management, and system interface management.

Data acquisition management mainly manages the input and storage of the data.

Evaluation rules management mainly manages the method of all kinds of evaluation.

Single evaluation management mainly manages the evaluation analysis of the first level of factor according to the second level of factor.

Comprehensive evaluation management mainly manages simulated analysis based on the comprehensive evaluation of the teachers' quality construction in specific ethnic areas.

Comparison evaluation management mainly manages the comparison based on the simulated analysis of the comprehensive evaluation of the teachers' quality construction in different ethnic areas.

Tendency evaluation management mainly manages the comprehensive evaluation and simulation analysis of the quality construction trend of the teachers in the ethnic regions of specific areas according to the change trend of the first and second level factors.

System integrated management mainly manages specific settings, operating systems and so on.

System security management mainly manages account, password, firewall and other security measures.

System help management mainly manages guidance and help information.

System interface management mainly manages system extension and connection between main management system and external system.

### 4.2 The Structure of the System Network

The structure of the system network is shown in Fig. 2.

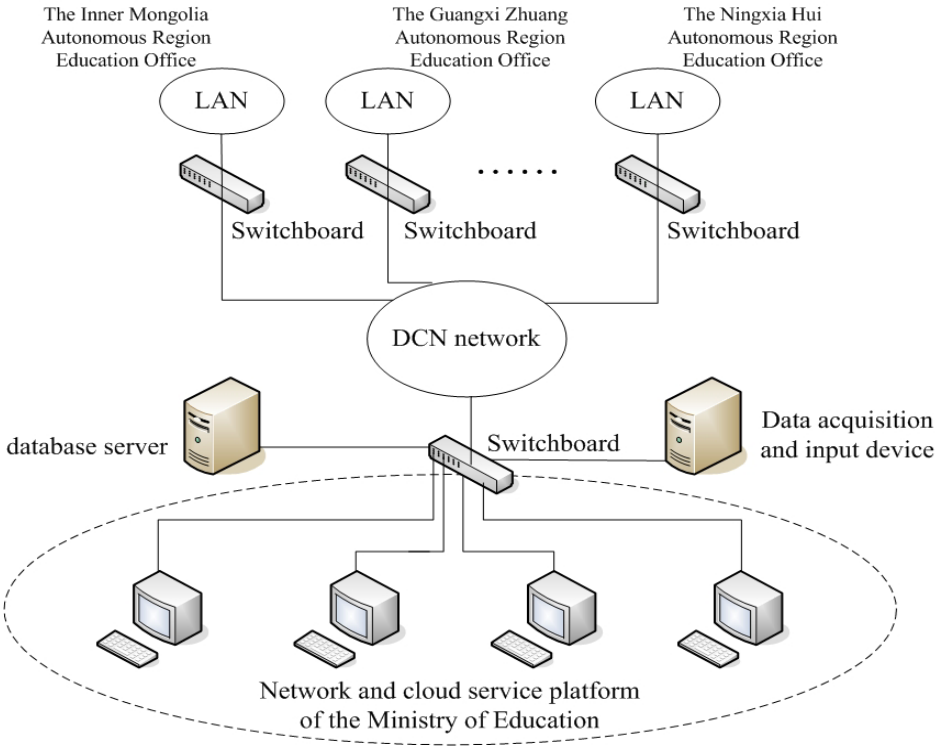


**Fig. 2.** The structure of the network

The structure of the system network contains data acquisition and input device, database server, DCN network, switchboard, network and cloud service platform of the Ministry of Education, and LAN of relevant autonomous region education office. The network and the cloud service platform of the Ministry of education, the local area network of relevant of the Provincial Education Hall realize the access to the quality construction data of the teachers' in the ethnic areas and the comprehensive evaluation simulation analysis through the data communication network and switch.

# 5 Case Analysis

## 5.1 Actual Case

The case analysis is based on the provincial ethnic areas, especially Inner Mongolia, Guangxi, Ningxia and Qinghai. The minority population of Qinghai is close to half (about 47%) of its total population although it is not National Autonomous Region. We take the capital, Beijing, and the national average as the contrast group for this research. Based on the data of the educational statistic yearbook of China [20] and the statistic yearbook of China [21]. The values of various regional factor set are shown as shown in the following table.

**Table 1.** The regional factor set value

| The first-level factors set | The second-level factors set | province | | | | | |
|---|---|---|---|---|---|---|---|
| | | Beijing (contrast group) | Inner Mongolia | Guangxi | Qinghai | Ningxia | National average (contrast group) |
| $U_1$ | $u_{11}$ | 45516.37 | 16301.67 | 9507.61 | 14915.34 | 11929.40 | 9557.89 |
| | $u_{12}$ | 12.54 | 13.50 | 8.71 | 12.19 | 7.99 | 8.14 |
| | $u_{13}$ | 15.12 | 15.72 | 11.47 | 15.51 | 12.11 | 13.36 |
| $U_2$ | $u_{21}$ | 118198 | 72064 | 38027 | 43531 | 47194 | 53980 |
| | $u_{22}$ | 6.3 | 6.8 | 6.3 | 7.1 | 7.0 | 6.1 |
| | $u_{23}$ | 1.19 | 0.68 | 0.56 | 0.76 | 1.02 | 0.65 |
| $U_3$ | $u_{31}$ | 5028 | 1937 | 2279 | 1319 | 2225 | 2530 |
| | $u_{32}$ | 14.97 | 17.37 | 17.78 | 15.26 | 17.07 | 17.07 |
| | $u_{33}$ | 3.36 | 0.71 | 0.63 | 0.52 | 2.44 | 1.90 |

Comprehensively considering the evaluation opinions of some experts, education administrators, and front-line teachers in this field, we finally determine the weights of the factors containing the first-level factor set and the second-level factor set, which is as shown in the following table.

**Table 2.** The factor weights for the first-level sets and second-level factor sets

| First-level factors set | Weight of first-level factors | Second-level factors set | Weight of second-level factors |
|---|---|---|---|
| $U_1$ | $\lambda_1$=38% | $u_{11}$ | $w_{11}$=70% |
| | | $u_{12}$ | $w_{12}$=15% |
| | | $u_{13}$ | $w_{13}$=15% |
| $U_2$ | $\lambda_2$=34% | $u_{21}$ | $w_{21}$=40% |
| | | $u_{22}$ | $w_{22}$=22% |
| | | $u_{23}$ | $w_{23}$=38% |
| $U_3$ | $\lambda_3$=28% | $u_{31}$ | $w_{31}$=60% |
| | | $u_{32}$ | $w_{32}$=10% |
| | | $u_{33}$ | $w_{33}$=30% |

Using the algorithm of the Fuzzy evaluation, the system establishes membership functions requiring the maximum aij and minimum bij of each second-level factor, which can be obtained by calculating the case data given by Table 1. The interval value of each second-level factors is shown in the following table.

We can get the degree of membership of each second-level factors based on the membership function (1) and data in Table 3. The membership after calculation is shown in the following table.

**Table 3.** The interval value of the second-level factors

| Second-level factors set | Maximum value | Minimum value |
|---|---|---|
| $u_{11}$ | $a_{11}$=45516.37 | $b_{11}$=9507.61 |
| $u_{12}$ | $a_{11}$=13.50 | $b_{12}$=7.99 |
| $u_{13}$ | $a_{13}$=15.72 | $b_{13}$=11.47 |
| $u_{21}$ | $a_{21}$=118198 | $b_{21}$=38027 |
| $u_{22}$ | $a_{22}$=7.1 | $b_{22}$=6.1 |
| $u_{23}$ | $a_{23}$=1.19 | $b_{23}$=0.56 |
| $u_{31}$ | $a_{31}$=5028 | $b_{31}$=1319 |
| $u_{32}$ | $a_{32}$=17.78 | $b_{32}$=14.97 |
| $u_{33}$ | $a_{33}$=3.36 | $b_{33}$=0.52 |

**Table 4.** The membership after calculation

| First-level factors set | Second-level factors set | province | | | | | |
|---|---|---|---|---|---|---|---|
| | | Beijing (contrast group) | Inner Mongolia | Guangxi | Qinghai | Ningxia | National average (contrast group) |
| $U_1$ | $u_{11}$ | 1 | 0.189 | 0 | 0.150 | 0.067 | 0.001 |
| | $u_{12}$ | 0.826 | 1 | 0.131 | 0.762 | 0 | 0.027 |
| | $u_{13}$ | 0.859 | 1 | 0 | 0.951 | 0.151 | 0.445 |
| $U_2$ | $u_{21}$ | 1 | 0.425 | 0 | 0.069 | 0.114 | 0.199 |
| | $u_{22}$ | 0.200 | 0.700 | 0.200 | 1 | 0.900 | 0 |
| | $u_{23}$ | 1 | 0.190 | 0 | 0.317 | 0.730 | 0.143 |
| $U_3$ | $u_{31}$ | 1 | 0.167 | 0.259 | 0 | 0.244 | 0.327 |
| | $u_{32}$ | 1 | 0.146 | 0 | 0.897 | 0.253 | 0.253 |
| | $u_{33}$ | 1 | 0.067 | 0.039 | 0 | 0.676 | 0.486 |

According to the calculation of the membership mentioned above, the evaluation matrix of "policy support", the judgment matrix of "economic and social infrastructure" and the judgment matrix of "talent resource foundation" are:

$$M_1=\begin{bmatrix} 1 & 0.189 & 0 & 0.150 & 0.067 & 0.001 \\ 0.826 & 1 & 0.131 & 0.762 & 0 & 0.027 \\ 0.859 & 1 & 0 & 0.951 & 0.151 & 0.445 \end{bmatrix},$$

$$M_2=\begin{bmatrix} 1 & 0.425 & 0 & 0.069 & 0.114 & 0.199 \\ 0.200 & 0.700 & 0.200 & 1 & 0.900 & 0 \\ 1 & 0.190 & 0 & 0.317 & 0.730 & 0.143 \end{bmatrix},$$

$$M_3=\begin{bmatrix} 1 & 0.167 & 0.259 & 0 & 0.244 & 0.327 \\ 1 & 0.146 & 0 & 0.897 & 0.253 & 0.253 \\ 1 & 0.067 & 0.039 & 0 & 0.676 & 0.486 \end{bmatrix}$$

According to the table 2, the weight matrix of the second-level factor sets of "policy support", "economic and social infrastructure" and "talent resource foundation" are:

$$w_1=[0.7 \quad 0.15 \quad 0.15],$$
$$w_2=[0.4 \quad 0.22 \quad 0.38],$$
$$w_3=[0.6 \quad 0.1 \quad 0.3]$$

Simulation analysis of second-level comprehensive evaluation is based on the M( $\cdot$ , +) model, the result of which is as shown:

$$R_1 = w_1 \cdot M_1 = [0.953 \quad 0.432 \quad 0.020 \quad 0.362 \quad 0.070 \quad 0.072],$$
$$R_2 = w_2 \cdot M_2 = [0.824 \quad 0.396 \quad 0.044 \quad 0.368 \quad 0.521 \quad 0.134],$$
$$R_3 = w_3 \cdot M_3 = [1 \quad 0.135 \quad 0.167 \quad 0.090 \quad 0.375 \quad 0.367] \circ$$

We set the parameters of the first-level factors as λ1 =38%, λ2 =34%, λ3 =28%.

Simulation analysis of first-level comprehensive evaluation which is also based on the M( • , +) model is shown as follows.

$$R = \sum_{i=1}^{3} \lambda_i \cdot R_i = [0.922 \quad 0.337 \quad 0.069 \quad 0.288 \quad 0.309 \quad 0.176]$$

After a normalization process, the result are as follows.

$$R = [0.452 \quad 0.165 \quad 0.034 \quad 0.141 \quad 0.151 \quad 0.086]$$

We can get the score of the comprehensive evaluation of teachers' quality construction in these 4 ethnic minority areas comparing to the score that Beijing and the national average data get as the contrast group, making the quantitative evaluation comes true. As our capital, the construction of teachers' quality in Beijing is at a high level. When it comes to the situation of the whole country, on the one hand, the nine-year compulsory education has been popularized in our country, accelerating the development of the quality construction of education and teachers' team, on the other hand, due to the diversity of circumstances in various areas, the development of education in some areas, especially western ethnic areas still remains backward. Taking the experts' opinion into account, we treat Beijing as the full mark, that is, 100 in our research while we treat the national average data as 80. Based on the quantitative equation (2), the scores we get from the simulation analysis of the comprehensive evaluation of teachers' quality construction in various areas are shown as follows.

**Table 5.** The score for the simulation analysis ofthe comprehensive evaluation of teachers' quality construction

| | Beijing | Inner Mongolia | Guangxi | Qinghai | Ningxia | National average |
|---|---|---|---|---|---|---|
| score | 100 | 84.32 | 77.16 | 83.01 | 83.55 | 80 |

### 5.2 Comparison Analysis

The evaluation of teachers' quality construction mainly considers various factors separately with qualitative analysis, thinking little of comprehensive analysis. Considering the quantitative comprehensive analysis of teachers' quality construction apart from the method mentioned by this paper, the current approach takes the balanced development of compulsory education at the county level as the evaluation standard, which reflects the development of teachers' quality construction. The higher proportion of counties that achieve balanced development of compulsory education in the province, the more perfect the quality of teachers is [22]. According to the data published by the Ministry of Education, the balanced development of compulsory education at the county level by 2016 is shown in the Table 6.

**Table 6.** The balanced development of compulsory education at county level in relevant areas

| | Beijing | Inner Mongolia | Guangxi | Qinghai | Ningxia | National average |
|---|---|---|---|---|---|---|
| Count of balanced development county of compulsory education | 16 | 61 | 30 | 20 | 15 | 1824 |
| Count of county | 16 | 103 | 111 | 43 | 22 | 2851 |
| The proportion of balanced development county of compulsory education | 100.0% | 59.2% | 27.0% | 46.5% | 68.2% | 64.0% |

Taking Beijing as a full score of 100 points and the national average data as 80 points, the proportion can be calculated quantitatively. The results are as follows in Table 7.

**Table 7.** The score of teachers' quality construction using the balanced development of compulsory education at county level

| | Beijing | Inner Mongolia | Guangxi | Qinghai | Ningxia | National average |
|---|---|---|---|---|---|---|
| score | 100 | 77.33 | 59.44 | 70.28 | 82.33 | 80 |

In order to compare this method with the current method of balanced development of compulsory education at county level, we need to compare the evaluation results of these two methods and the actual situation of the quality construction of the teachers. "The proportion of teachers with bachelor degree or above" is the index data that charactering the quality construction of teachers. Although it can't reflect the influence of the related factors on the quality construction of the teachers' team nor can be used to study the trend of quality construction of the teachers' team according to the changes of the related factors as the two methods mentioned above, it can be used to judge teachers' quality construction in a time point, so that it can be used as the reference standard for the comprehensive evaluation and the effectiveness of the comprehensive evaluation results. According to the total number of teachers in each area and the number of teachers with bachelor degree or above, the proportion of teachers with bachelor degree or above in each area can be calculated, which is as shown in Table 8.

**Table 8.** The proportion of teachers with bachelor degree or above for the junior high school stage of compulsory education in relevant areas

| | Beijing | Inner Mongolia | Guangxi | Qinghai | Ningxia | National average |
|---|---|---|---|---|---|---|
| count of teachers | 33469 | 57069 | 123427 | 16171 | 19740 | 3487789 |
| Count of teachers with bachelor | 27751 | 48247 | 96215 | 12795 | 17731 | 2799585 |
| Count of teachers with graduate student | 5362 | 2010 | 1350 | 351 | 347 | 76857 |
| Count of teachers with bachelor or above | 33113 | 50257 | 97565 | 13146 | 18078 | 2876442 |
| The proportion of teachers with bachelor or above | 98.94% | 88.06% | 79.05% | 81.29% | 91.58% | 82.47% |

Taking Beijing as a full score of 100 points and the national average data as 80 points, the proportion of teachers with bachelor degree or above can be calculated quantitatively as it can be seen in Table 9.

**Table 9.** Reference standard score table for quality construction of teachers

| | Beijing | Inner Mongolia | Guangxi | Qinghai | Ningxia | National average |
|---|---|---|---|---|---|---|
| score | 100 | 86.79 | 75.85 | 78.57 | 91.06 | 80 |

Comparing the method this paper mentioned with the current balanced development method of compulsory education at county level as well as the reference standard, contrast diagram can be seen in Fig. 3 while the contrast data can be seen in Table 10. In Fig. 3, Plan 1 is the evaluation method mentioned by this paper, and Plan 2 takes the balanced development method of compulsory education in county level, and Standard Date is the reference standard.

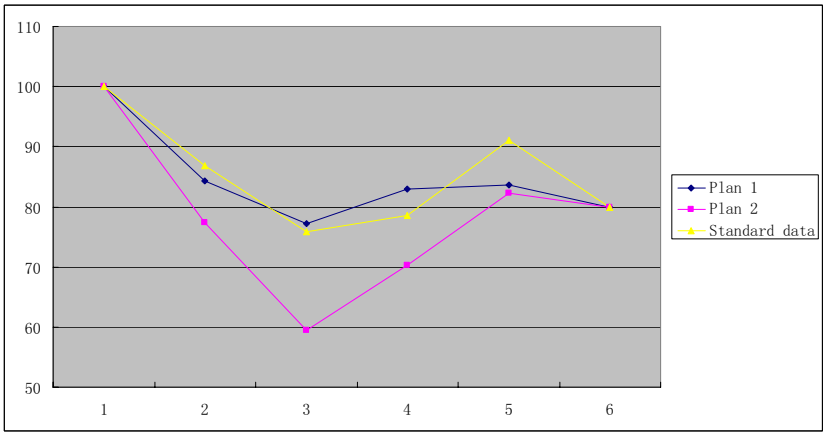


**Fig. 3.** Contrast figure of the evaluation

**Table 10.** Contrast table of the evaluation

| | Plan1 | | Plan2 | | Reference Standard |
|---|---|---|---|---|---|
| | Score | Error | Score | Error | |
| Inner Mongolia | 84.32 | 2.85% | 77.33 | 10.90% | 86.79 |
| Guangxi | 77.16 | 1.73% | 59.44 | 21.63% | 75.85 |
| Qinghai | 83.01 | 5.65% | 70.28 | 10.55% | 78.57 |
| Ningxia | 83.55 | 8.25% | 82.33 | 9.59% | 91.06 |

The paper takes such function to calculate the error parameter e in Table 10, representing the degree of error between the simulation value and actual value.

$$e = \frac{|a-b|}{b} \times 100\% .$$

Where a is the evaluation result and b is reference standard.

In this paper, the error parameters which have already been tested and verified according to the comprehensive evaluation result get from this paper are all within 8% thus drawing the conclusion that this method gives a good fitting to the real system and the method with its structure are effective.

According to Fig. 1, the results obtained in this paper are closer to the reference standard. According to Table 9, the average error of the evaluation method is 4.62%, which is far less than the average error of 13.17% of the current balanced development method of compulsory education in the county area.

## 6 Conclusions

Aiming at the problem of that common methods utilizing to evaluate the teachers' quality focus on qualitative analysis and are lack of comprehensive analysis, this paper proposes the comprehensive evaluation model of teachers' quality construction in ethnic areas based on the fuzzy evaluation, establishing a suitable membership function and quantitative formula to improve the comprehensive evaluation effect. Meanwhile, we can study and evaluate the trend of the quality of teachers in ethnic areas through the changing trend of related factors. Based on the actual evaluation, this paper enumerates the analysis and evaluation cases of four ethnic provinces and regions to verify the effectiveness of the proposed model, and the experimental result shows that the new model gets more accurate results.

In this paper, we develop the system of teachers' quality construction in ethnic areas based on Java and ORACLE, realizing the hierarchical definition of the influencing factors, and has the real-time updating function of the evaluation data and parameters. And it achieves satisfactory results in the running process. However, the problem that different evaluation indexes may conflict with each other have a great influence on the experimental result. Furthermore, the evaluation method proposed in this paper has great relevance, lacking of universality. These problems will be solved in the future work.

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