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Analysis of training mode for medical students in general medical education

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Abstract. An evaluation method of general practice education and talents training mode based on fuzzy TOPSIS decision fusion is proposed for a scientific and reasonable analysis of general practice education and talents training mode and for an improvement of training mode. Firstly, an evaluation index system mainly including teacher's teaching abilities, specialty construction, practice teaching and teaching management as well as other multiple modes is established. Then, a selection method of secondary evaluation data for fuzzy time-varying weighting factor proposed is adopted, which realizes the efficient analysis of general practice education and talents training mode. At last, the proposed method is verified its effectiveness through case analysis.

Key words. Fuzzy rules, TOPSIS decision, General practice, Talents training.

1. Introduction

Talents training mode of general practice education is the sum of training objectives, teaching contents, training methods and security mechanism that are determined by the school and employer in accordance with education objectives under the guidance of certain educational ideas and educational concepts, and a programmed pattern formed in practice. It is mainly developed surrounding "what kind of talents to train" and "how to train" the two basic issues, and is the crystallization of theoretical research and practical exploration, of which solid practical basis should be emphasized especially. Accordingly, talents training mode include 3 levels of contents. The first level: objective system, mainly means training objectives and specifications; the second level: content method system, mainly means teaching contents, teaching methods and means, training ways, etc; the third level: security system, mainly means teachers team, practice base, teaching management and teaching evaluation, etc.

Professional teaching plan of general practice must be established in accordance with following principles: the principle of comprehensive development; pertinence

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highlighted and adaptability considered principle; ability training principle of comprehensive medical profession; integration and optimization principle. The graduates from clinical medicine of general practice education are the applied technical talents in medicine facing countryside and community the first line. The four-stage curriculum method of "basic course, basic theory course, specialized course and clinical practice" in regular medical college (technical college) shall not be adopted as the curriculum system, but "two pieces and three blocks" should be adopted, namely common course teaching and specialized course teaching the two pieces, and common course, professional theory course and professional practice course the three blocks. Such curriculum system focusing on application and regarding ability as the core can better realize the training objectives of clinical medicine. In the past, teaching means mainly adopt blackboard-chalk teaching, which is boring and monotonous. With the promotion of multimedia teaching means, network multimedia teaching will adopt internet technology and multimedia technology to help students learn on line at any time, choose learning contents and progress freely as well as realize two-way interaction of teaching fully. In medical education, morphology content accounts for a large proportion: various image contents in disciplines such as human anatomy, tissue and embryo, pathology and image diagnosis, and time of teachers' explanation flow on images in teaching can be reduced through multimedia means, but understanding of knowledge is deepened.

An evaluation method of general practice education and talents training mode based on fuzzy TOPSIS decision fusion is proposed to construct an evaluation index system mainly including teachers' teaching abilities, specialty construction, practice teaching and teaching management as well as other multiple modes for the improvement of scientificity and rationality of general practice education and talents training mode in the Paper. And then, the proposed fuzzy TOPSIS decision fusion method realizes the effective analysis of general practice education and talents training mode.

2. Determination of the index system

The following performance evaluation index system for general practice talents training mode is established after the factor analysis and correlation analysis of data which is obtained through our questionnaire surveys on the graduates from general practice specialty:

$A = \{B_1, B_2, B_3, B_4, B_5\}$ = { teachers' teaching abilities, specialty construction, practice teaching, teaching management, teaching quality monitoring}

$B_1 = \{C_1, C_2, C_3, C_4, C_5\}$ = { teaching attitude, teaching contents design, teaching effect, teaching means and methods, disciplinary knowledge level}

$B_2 = \{C_6, C_7, C_8, C_9, C_{10}\}$ = { school-running characteristics, curriculum structure, research strength, textbook construction, specialty facilities}

$B_3 = \{C_{11}, C_{12}, C_{13}, C_{14}\}$ = { specialty practice, experimental teaching, social practice, graduation thesis design}

$B_4 = \{C_{15}, C_{16}, C_{17}, C_{18}\}$ ={ teaching system construction, teaching-affairs administration, construction of study style, teaching reform}

$B_5 = \{C_{19}, C_{20}, C_{21}, C_{22}\}$ ={ students' evaluation of teaching, scholarship assessment, teaching quality evaluation, follow-up survey for quality of the graduates}

In group decisions, the society environment, personnel experiences, experience, cultural background and personnel demands, preferences of each expert are different, which will all cause that the judgment matrix provided and expert individual ranking vector obtained are not always the same. Therefore, how to determine the influence of each expert's individual ranking vector in comprehensive vectors, namely what is the weight of each expert, is the first problem we need to solve. As for calculations of expert weight under certain criterion, two classifications can be divided roughly at present: the first classification is to empower according to the consistency degree of judgment matrix provided by experts, with the thought that the better the consistency degree of judgment matrix is, the greater the expert weight will be correspondingly; another classification is an idea based on majority principle, with the thought that the more experts whose ranking schemes are closer to each other are, indicating the higher the consensus degree between experts is, the stronger the accuracy of judgment is correspondingly, then the bigger the expert weight is. Guo Wenming et. al. have applied the theoretical method of pattern recognition to group analytical hierarchy process, viewing expert individual ranking vector as a sample to be recognized, using cluster analysis of expert ranking vector to judge the sample's dependability and empowering expert according to the clustering results; the method is called as group AHP cluster analysis. Namely clustering calculation is conducted according to the compatibility degree of individual ranking vector of expert judgment matrix, so as to determine expert classification; the weight between classifications is determined according to the size of classification capacity, and the expert weight in classification is determined according to the consistency proportion of each expert in the classification; at last, weight between classifications and weight in classification are combined to calculate the weight of comprehensive vector of each index under the criterion, namely the comprehensive ranking vector of each index under the criterion.

3. Fuzzy TOPSIS decision fusion

3.1. Steps for decision fusion

In former literatures, TOPSIS criterion weight W_C is assigned based on the preference of user (or recommender), but in reality, such weight value is difficult to obtain accurately due to the multi-source of QoS criterion, since QoS information with different sources can not be quantified uniformly, even problems such as information loss, information overlap exist. Algorithm steps selected for secondary evaluation data of fuzzy time-varying weight factor TOPSIS are proposed as follows in order to solve above problems:

Step 1: Assumed that there are m evaluation data $S_i\,(i = 1, 2, \cdots, m)$ available in total, and QoS decision criterion is $C_j\,(j = 1, 2, \cdots, n)$, then the QoS decision matrix of evaluation data under all times can be expressed as:

$$X = \begin{array}{c} \\ S_1 \\ S_2 \\ \vdots \\ S_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \left[\begin{array}{cccc} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{array} \right] \end{array} . \tag{1}$$

In which, x_{ij} represents the quantification presentation of evaluation data S_i under the criterion C_j.

Step 2: Render an assignment to the weight coefficient of decision criterion based on entropy, firstly normalize decision matrix under the criterion C_j $(j = 1, 2, \cdots, n)$ to obtain corresponding projection P_{ij}:

$$P_{ij} = x_{ij} \Big/ \sum\nolimits_{i=1}^{m} x_{ij} \, . \tag{2}$$

Entropy can be defined as:

$$e_j = -\left(\ln m\right)^{-1} \cdot \sum_{j=1}^{n} p_{ij} \ln p_{ij} \, . \tag{3}$$

Criterion weight can be defined as:

$$W_{C_j} = (1 - e_j) \Big/ \sum\nolimits_{k=1}^{n} (1 - e_k) \, . \tag{4}$$

Step 3: Fuzzy TOPSIS fusion evaluation matrix can be expressed as:

$$\tilde{R} = [\tilde{r}_{ij}]_{m \times n} \, . \tag{5}$$

In time-varying process, the change amplitude of price is the biggest, and has the biggest influence on selections of evaluation data, therefore, price element is classified into price correlation (C) and function correlation (F) more specifically in fusion evaluation. Assuming fuzzy number is (a_{ij}, b_{ij}, c_{ij}), then triangular fuzzy rule is:

$$\begin{cases} \tilde{r}_{ij} = \left(\dfrac{a_{ij}}{c_j^+}, \dfrac{b_{ij}}{c_j^+}, \dfrac{c_{ij}}{c_j^+} \right), & j \in F \\ \tilde{r}_{ij} = \left(\dfrac{a_j^-}{c_{ij}}, \dfrac{a_j^-}{b_{ij}}, \dfrac{a_j^-}{a_{ij}}, \right), & j \in C \end{cases} \tag{6}$$

In which parameters are:

$$\begin{cases} c_j^+ = \max c_{ij} \, , & if \;\; j \in F \\ a_j^- = \min a_{ij} \, , & if \;\; j \in C \end{cases} \tag{7}$$

Step 4: Based on the weight value obtained in step 2 and the fuzzy decision matrix obtained in step 3, it can be deduced that evaluation matrix is:

$$\tilde{V} = \begin{bmatrix} \tilde{v}_{11} & \tilde{v}_{12} & \cdots & \tilde{v}_{1n} \\ \tilde{v}_{21} & \tilde{v}_{22} & \cdots & \tilde{v}_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \tilde{v}_{n1} & \tilde{v}_{n2} & \cdots & \tilde{v}_{nn} \end{bmatrix} = \begin{bmatrix} \tilde{r}_{11} & \tilde{r}_{12} & \cdots & \tilde{r}_{1n} \\ \tilde{r}_{21} & \tilde{r}_{22} & \cdots & \tilde{r}_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \tilde{r}_{m1} & \tilde{r}_{m2} & \cdots & \tilde{r}_{mn} \end{bmatrix} \cdot diag\left\{W_{C_1}, \cdots W_{C_n}\right\} . \tag{8}$$

Step 5: Through evaluation ranks on the evaluation matrix obtained in step 4, corresponding positive and negative ideal solution A^+ and A^- can be obtained with forms as follows:

$$\begin{cases} A^+ = \left(\tilde{v}_1^+, \tilde{v}_2^+, \cdots, \tilde{v}_n^+\right) , \\ A^- = \left(\tilde{v}_1^-, \tilde{v}_2^-, \cdots, \tilde{v}_n^-\right) . \end{cases} \tag{9}$$

Step 6: Referring to Bojadziev G[9] and other people's methods, Euclidean distance of triangular fuzzy numbers $A_1 = (a_1, b_1, c_1)$ and $A_2 = (a_2, b_2, c_2)$ can be calculated with forms as follows:

$$d\left(A_1, A_2\right) = \sqrt{\frac{1}{3}\left[\left(a_1 - a_2\right)^2 + \left(b_1 - b_2\right)^2 + \left(c_1 - c_2\right)^2\right]} .$$

$$\begin{cases} d_i^+ = \sum\limits_{j=1}^{k} d\left(\tilde{v}_{ij}, \tilde{v}_j^+\right), i = 1, 2, \cdots m \\ d_i^- = \sum\limits_{j=1}^{k} d\left(\tilde{v}_{ij}, \tilde{v}_j^-\right), i = 1, 2, \cdots m \end{cases} \tag{10}$$

Step 7: Solve and rank the approximate index (CC) of evaluation data, and then select the optimum evaluation data in accordance with the ranking results:

$$CC_i = \frac{d_i^-}{d_i^+ + d_i^-} . \tag{11}$$

3.2. Time-varying secondary quantification

Rendering weight assignments on QoS discrimination criterion of all times to realize the distinguishment of QoS characteristic influences of all times. And the basis of weight assignment is that real-timeQoS characteristics are more important. Assuming that there are n times $t_1, t_2, \cdots, t_n$, then the weight of each time t_i can be defined based on the following function:

$$\omega_i = A + \frac{K - A}{\left(1 + e^{-B(\Delta t_i - M)}\right)^{0.5}} . \tag{12}$$

In the formula, $\Delta t_i$is the interval between real time period and reference time. B is the influence parameter of growth rate, M is the allowed largest interval, A is the lower envelop line, and K is the upper envelop line. Considering that the weight of real-time period is set as 1, which is reduced to 0.4 (the lower limit of weight) gradually with the advancement of time, Boole matrix is constructed with forms as follows in order to keep the independence of alternative use of the supreme level of service:

$$U = \begin{array}{c} \\ S_1 \\ S_2 \\ \vdots \\ S_m \end{array} \begin{array}{c} \begin{array}{cccc} t_1 & t_2 & \cdots & t_n \end{array} \\ \begin{bmatrix} u_{11} & u_{12} & \cdots & u_{1n} \\ u_{21} & u_{22} & \cdots & u_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ u_{m1} & u_{m2} & \cdots & u_{mn} \end{bmatrix} \end{array}. \quad (13)$$

In above formula, u_{ij} is the corresponding Boole matrix element of evaluation data S_i and time t_j, if evaluation data S_i is the highest service level under time t_j, then $u_{ij} = 1$. The column vector of above Boole matrix expresses the result of multi-attribute fusion evaluation of evaluation data under the time, and row vector expresses the result of multi-attribute fusion evaluation of the evaluation data under all times. Then fusion level R_i can be defined as follows:

$$R_i = \sum_{j=1}^{n} \omega_j u_{ij} \quad (14)$$

In which, ω_j is time-varying weight. Above processes shall be executed repeatedly on all evaluation data to obtain the rankings of all evaluation data under all times. Above processes can be presented by the formula below:

$$\begin{bmatrix} R_1 \\ R_2 \\ \vdots \\ R_m \end{bmatrix} = \begin{bmatrix} u_{11} & u_{12} & \cdots & u_{1n} \\ u_{21} & u_{22} & \cdots & u_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ u_{m1} & u_{m2} & \cdots & u_{mn} \end{bmatrix} \cdot \begin{bmatrix} \omega_1 \\ \omega_2 \\ \vdots \\ \omega_n \end{bmatrix}. \quad (15)$$

Based on the fusion level R obtained in above formula, rank and obtain the evaluation data S_k of the highest level R_k, S_k is the final selection result of evaluation data that is recommended to user (inquirer).

4. Steps of algorithm

In evaluation of data selection, QoS criterion within certain time of period is combined to consider based on time-varying weight method, rather than the real time point or average time way used in literature [10], so as to solve local extreme or QoS characteristic time loss more effectively in selection process of evaluation data. Steps of algorithm are as follows:

Step 1: (time division) divide QoS characteristics in certain time according to time sequence to obtain relatively independent small time, and use the discrimination criterion C_j $(j = 1, 2, \cdots, n)$ selected by user to evaluate QoS characteristics of evaluation data in independent small time; use fuzzy TOPSIS multi-criteria decision module in Fig. 1 to select from QoS information base;

Step 2: (criterion selection) simplify selection method of discrimination criterion based on entropy QoS and according to users' preference to obtain the discrimination criterion C_j $(j = 1, 2, \cdots, n)$, and see Section 2.2 for step 1 to 2;

Step 3: (level ranking) construct decision matrix on QoS characteristics in all times based on available evaluation data, and use decision time-varying weight and fuzzy TOPSIS to obtain relatively high-quality evaluation data for fusion evaluation. For the mutual independence of small times, fuzzy TOPSIS evaluation data can be selected in machines, and see Section 2.2 for step 3 to step 7;

Step 4: (secondary quantification) render weight assignment according to times, and the method is to render 1-0.4 weight in turn with 0.4 as lower limit of weight based on the interval between time and current time put forward since now; above process presents real-time QoS characteristics are more important than that in the past while the later are considered at the same time. Conduct infusion evaluation on the optimal selection result of all times obtained in step 3 by the set time-varying weight, select the final evaluation data result and recommend it.

5. Case analysis

Above methods are applied to analyze the performance of general practice talents training mode of certain college, and the specific algorithm processes are as follows:

(1) Determination of index weight. Construct judgment matrix and organize 7 experts to judge the importance degree of each index element on 5 secondary indexes and 1 first index. In judgment matrix, to present the estimated value of relative importance degree of ith element to jth element in one certain index, 1-9 scale method is adopted in importance scale. We determine the comprehensive weight of index on results achieved according to determination method steps of each weight in aforementioned group AHP:

① Calculate the maximum characteristic root and characteristic vector of index judgment matrix done by each expert, and the normalized characteristic vector is the ranking weight of relative importance of each element in the index, in other words, it is the expert's individual ranking vector on the index.

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(AW)_i}{nw_i} .$$

② Conduct consistency check on judgment matrix done by each expert by calculating consistency proportion, in which consistency proportion:

$$CR = \frac{CI}{RI}, CI = \frac{\lambda_{\max} - n}{n - 1} .$$

Generally, only when CR <0.10, it can be considered that the judgment matrix is a consistency judgment matrix.

③ Calculate compatibility degree of individual ranking vector of each expert under the same index and construct compatibility matrix; conduct expert clustering analysis according to the steps listed, and calculate the expert clustering result under each index of expert.

④ Combine the calculation results of expert clustering analysis of each index to calculate the weight of each expert between classifications under the index; calculate the weight of each expert in classification under the index; calculate the comprehensive weight of each index according to the calculation results of weight between classifications and weight in classification. The comprehensive weight of each index finally obtained is as follows:

$$\begin{aligned}
W &= (0.276, 0.305, 0.218, 0.104, 0.097)\,;\\
W_1 &= (0.258, 0.168, 0.206, 0.101, 0.267)\,;\\
W_2 &= (0.285, 0.331, 0.105, 0.08, 0.199)\,;\\
W_3 &= (0.359, 0.229, 0.101, 0.311)\,;\\
W_4 &= (0.113, 0.263, 0.489, 0.135)\,;\\
W_5 &= (0.148, 0.24, 0.268, 0.344)\,.
\end{aligned}$$

(2) Determination of evaluation matrix. 50 general practice graduates are invited to evaluate each index by means of questionnaire survey according to the determined comment level and quantification method, and the evaluation matrix is determined as follows:

$$R_1 = \begin{bmatrix} 0.34 & 0.28 & 0.28 & 0.28 & 0.02 \\ 0.42 & 0.26 & 0.24 & 0.06 & 0.02 \\ 0.50 & 0.34 & 0.10 & 0.06 & 0.00 \\ 0.42 & 0.38 & 0.12 & 0.08 & 0.00 \\ 0.36 & 0.34 & 0.22 & 0.08 & 0.02 \end{bmatrix},$$

$$R_2 = \begin{bmatrix} 0.04 & 0.10 & 0.60 & 0.20 & 0.06 \\ 0.06 & 0.08 & 0.58 & 0.22 & 0.66 \\ 0.06 & 0.12 & 0.40 & 0.32 & 0.10 \\ 0.08 & 0.26 & 0.42 & 0.20 & 0.04 \\ 0.04 & 0.14 & 0.04 & 0.28 & 0.14 \end{bmatrix},$$

$$R_3 = \begin{bmatrix} 0.04 & 0.12 & 0.30 & 0.40 & 0.14 \\ 0.02 & 0.20 & 0.34 & 0.28 & 0.16 \\ 0.00 & 0.20 & 0.44 & 0.24 & 0.12 \\ 0.02 & 0.28 & 0.44 & 0.22 & 0.04 \end{bmatrix},$$

$$R_4 = \begin{bmatrix} 0.04 & 0.18 & 0.48 & 0.26 & 0.04 \\ 0.04 & 0.16 & 0.46 & 0.30 & 0.04 \\ 0.02 & 0.14 & 0.46 & 0.36 & 0.02 \\ 0.06 & 0.24 & 0.48 & 0.18 & 0.04 \end{bmatrix},$$

$$R_5 = \begin{bmatrix} 0.02 & 0.24 & 0.44 & 0.26 & 0.04 \\ 0.02 & 0.28 & 0.50 & 0.14 & 0.06 \\ 0.02 & 0.22 & 0.52 & 0.18 & 0.06 \\ 0.04 & 0.10 & 0.50 & 0.26 & 0.10 \end{bmatrix} .$$

(3) Comprehensive evaluation:

$$\begin{aligned} &B_1 = W_1 \cdot R_1 = (0.400, 0.315, 0.204, 0.067, 0.014)\,, \\ &B_2 = W_2 \cdot R_2 = (0.052, 0.116, 0.518, 0.235, 0.079)\,, \\ &B_3 = W_3 \cdot R_3 = (0.025, 0.196, 0.367, 0.301, 0.111)\,, \\ &B_4 = W_4 \cdot R_4 = (0.033, 0.163, 0.465, 0.309, 0.030)\,, \\ &B_5 = W_5 \cdot R_5 = (0.027, 0.196, 0.496, 0.210, 0.071)\,, \\ &R = (B_1, B_2, B_3, B_4, B_5)^T\,, \\ &A = W \cdot R = (0.138, 0.201, 0.391, 0.208, 0.062)\,. \end{aligned}$$

Quantifying the comprehensive evaluation results according to the determined quantification method, it can be got:

$$V = A \cdot V^T = 62.89\,.$$

It indicates that the performance level of general practice talents training mode of the college is general through comprehensive evaluation.

6. Conclusion

An evaluation method of general practice education and talents training mode based on fuzzy TOPSIS decision fusion is proposed in the Paper, which constructs the evaluation index system mainly including teachers' teaching abilities, specialty construction, practice teaching, teaching management and other multiple modes, and realizes the effective analysis of general practice education and talents training mode by means of the selection method of secondary evaluation data for fuzzy time-varying weight factor TOPSIS proposed; the experimental result shows that the proposed method can effectively realize evaluation on general practice education and talents training mode.

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