Research Journal of Applied Sciences, Engineering and Technology 5(13): 3582-3585, 2013
DOI:10.19026/rjaset.5.4492
ISSN: 2040-7459; e-ISSN: 2040-7467

Submitted: July 31, 2012 Accepted: September 17, 2012 Published: April 15, 2013

**Research Article**

# Study on Nursing Clinical Teachers' Comprehensive Quality Evaluation Model on the Basis of Fuzzy Mathematics

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**Abstract:** In this study, we study on the nursing clinical teachers' comprehensive quality evaluation model on the basis of fuzzy mathematics. First, it obtains the nursing clinical teachers' comprehensive quality evaluation index framework by making use of Delphi method. Then, it constructs the comprehensive quality evaluation hierarchy model by applying the analytic hierarchy process, to obtain the weight for each index, based on which to establish fuzzy comprehensive evaluation model, thus acquiring new method for nursing clinical teachers' comprehensive quality evaluation. Examples have proven the feasibility and effectiveness of this method.

**Keywords:** Fussy comprehensive evaluation, model, nursing clinical teacher

## INTRODUCTION

Nursing clinical teacher is an important component of higher education of nursing and the teachers' quality directly influences the growth of nursing students and the development of the school. Therefore, objective and effective evaluation to nursing clinical teachers' comprehensive quality is good for enhancing the nursing clinical teachers' quality and building the talent team for schools. Lee *et al*. (2002) have a research of the nursing students' and clinical educators' perceptions of characteristics of effective clinical educators in an Australian university school of nursing. Purcell and Lloyd-Fones (2003) study the standards for medical educator. Viverais-Dresler and Kutschke (2001) study the students' rating and opinions related to the importance of certain clinical teacher behaviors. Hou *et al*. (2006) have a research of the exploratory study on indexes evaluation system for core capability of clinical nursing teachers. Du and Pang (2006) analyze the modern comprehensive evaluation method and case selection. Zhijuan and Jiaming (2012) study the construction of nursing clinical teachers' comprehensive quality evaluation index system. Snell *et al*. (2000) give a review of the evaluation of clinical teaching: new perspectives and challenges. Baoqing (2004) shows the basis of fuzzy theory. Johnsen *et al*. (2002) have a research of the nurse educator competence: a study of Norwegian nurse educators' opinions of the importance and application of different nurse educator competence domains.

In this study, we study on the nursing clinical teachers' comprehensive quality evaluation model on the basis of fuzzy mathematics. First, it obtains the nursing clinical teachers' comprehensive quality evaluation index framework by making use of Delphi method. Then, it constructs the comprehensive quality evaluation hierarchy model by applying the analytic hierarchy process, to obtain the weight for each index, based on which to establish fuzzy comprehensive evaluation model, thus acquiring new method for nursing clinical teachers' comprehensive quality evaluation. Examples have proven the feasibility and effectiveness of this method.

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## HIERARCHICAL MODEL OF NURSING CLINICAL TEACHER'S COMPREHENSIVE QUALITY EVALUTION

According to the principles of guidance, completeness, science, feasibility and development, it conducts several rounds of questionnaire and expert consultation by making use of Delphi method. Meanwhile, through several stages such as decomposition, convergence, test, revise, verification and perfection, it further analyzes and selects factors to be investigated and then sequences these factors

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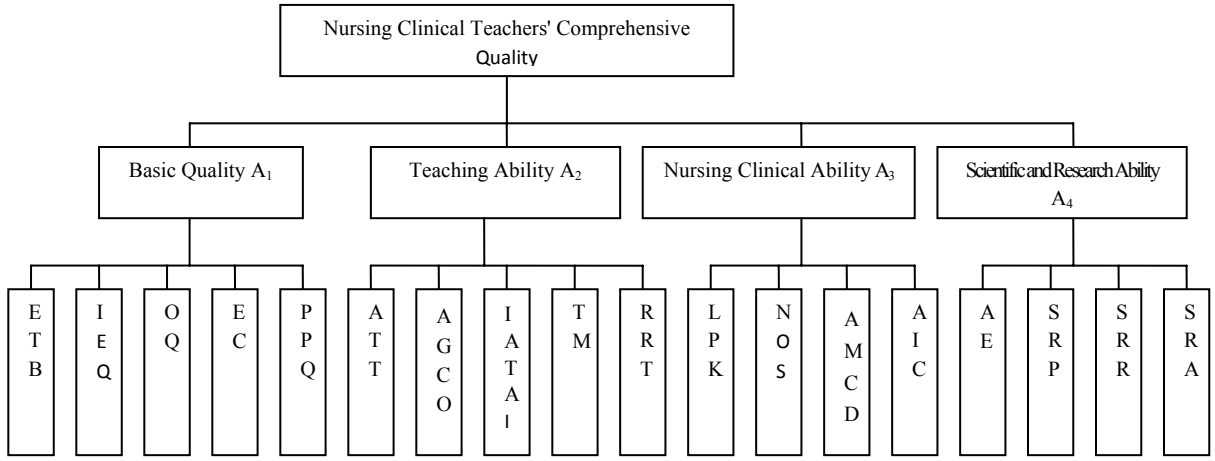


Fig. 1: Hierarchy model of nursing clinical teachers' comprehensive quality evaluation

through expert judgment, to determine key factors to be investigated, thus obtaining the index framework. By making use of analytic hierarchy method, it obtains the weight for each index, thus obtaining the hierarchical model of comprehensive quality evaluation, which is showed as Fig. 1:

Primary and secondary index weights are as follows:

Primary index weight: $\omega_1 = 0.201, \omega_2 = 0.298, \omega_3 = 0.298, \omega_4 = 0.203$:

Secondary index weight:

$\omega_{11} = 0.200, \omega_{12} = 0.200, \omega_{13} = 0.200, \omega_{14} = 0.200, \omega_{15} = 0.200$
$\omega_{21} = 0.198, \omega_{22} = 0.203, \omega_{23} = 0.203, \omega_{24} = 0.198, \omega_{25} = 0.198$
$\omega_{31} = 0.279, \omega_{32} = 0.275, \omega_{33} = 0.226, \omega_{34} = 0.220$
$\omega_{41} = 0.220, \omega_{42} = 0.226, \omega_{43} = 0.229, \omega_{44} = 0.275$

## FUSSY COMPREHENSIVE EVALUATION MODEL

**Index classification:** If the index set $U = (u_1, u_2, \ldots, u_p)$ is divided into m classes in accordance with the index attributes, i.e.:
They will meet the following conditions:

- $p_1 + p_2 + \ldots + p_m = p$;
- $U_1 \cup U_2 \cup \ldots \cup Um = U$
- $(\forall i, j)(i \neq j \Longrightarrow U_i \cap U_j = \emptyset$

**Establish evaluation set:**

$V = \{v_1, v_2, \ldots, v_n\}$

**Establish weight vector:**

- **Index weight vector:** Let the weight for the index Ui in the i class be, $\omega_i$ ($i = 1, 2, \ldots, m$) the index weight vector is:
  $\Omega = \{\omega_1, \omega_2, \ldots, \omega_m\}$,

- **Index weight vector:** Let the weight of the index $a_{ij}$ in the i class be $\omega_{ij}$, the index weight vector is:

  $\Omega_i = \{\omega_{i1}, \omega_{i2}, \ldots, \omega_m\}, i = 1, 2, \ldots, m$

## SINGLE LAYER COMPREHENSIVE EVALUATION MODEL

Providing the fussy single-factor evaluation matrix of the subordinate index for certain index is:

$$R_i = \begin{pmatrix} r_{11}^{(i)} \cdots r_{1n}^{(i)} \\ r_{21}^{(i)} \cdots r_{2n}^{(i)} \\ \vdots \cdots\cdots \vdots \\ r_{p_i 1}^{(i)} \cdots r_{p_i n}^{(i)} \end{pmatrix}$$

Then, the corresponding fussy comprehensive evaluation of each object is:

$$B_i = \Omega_i \circ R_i$$

$$= (\omega_{i1}, \omega_{i2}, \cdots, \omega_{ip_i}) \circ \begin{pmatrix} r_{11}^{(i)} \cdots r_{1n}^{(i)} \\ r_{21}^{(i)} \cdots r_{2n}^{(i)} \\ \vdots \cdots\cdots \vdots \\ r_{p_i 1}^{(i)} \cdots r_{p_i n}^{(i)} \end{pmatrix}$$

$$= (b_{i1}, b_{i2}, \cdots, b_{in})$$

**Multi-layer comprehensive evaluation model:** When the evaluation index in the system is no less than two layers, a multi-layer evaluation model is required,

Table 1: Score table for teacher as comprehensive quality

| Primary index | | Secondary index | | Evaluation class | | | | |
|---|---|---|---|---|---|---|---|---|
| Index Item | Weight | Index item | Weight | Excellent | Good | Medium | Qualified | Disqualified |
| $A_1$ | 0.201 | $a_{11}$ | 0.200 | 15 | 57 | 18 | 10 | 0 |
| | | $a_{12}$ | 0.200 | 16 | 68 | 14 | 2 | 0 |
| | | $a_{13}$ | 0.200 | 33 | 61 | 5 | 1 | 0 |
| | | $a_{14}$ | 0.200 | 39 | 58 | 3 | 0 | 0 |
| | | $a_{15}$ | 0.200 | 35 | 63 | 1 | 1 | 0 |
| $A_2$ | 0.298 | $a_{21}$ | 0.198 | 15 | 60 | 18 | 6 | 1 |
| | | $a_{22}$ | 0.203 | 31 | 66 | 2 | 1 | 0 |
| | | $a_{23}$ | 0.203 | 43 | 52 | 4 | 0 | 1 |
| | | $a_{24}$ | 0.198 | 41 | 42 | 12 | 5 | 0 |
| | | $a_{25}$ | 0.198 | 87 | 13 | 0 | 0 | 0 |
| $A_3$ | 0.298 | $a_{31}$ | 0.279 | 75 | 18 | 7 | 0 | 0 |
| | | $a_{32}$ | 0.275 | 84 | 15 | 0 | 1 | 0 |
| | | $a_{33}$ | 0.226 | 34 | 54 | 10 | 2 | 0 |
| | | $a_{34}$ | 0.220 | 86 | 12 | 2 | 0 | 0 |
| $A_4$ | 0.203 | $a_{41}$ | 0.220 | 0 | 10 | 85 | 10 | 0 |
| | | $a_{42}$ | 0.226 | 5 | 40 | 50 | 5 | 0 |
| | | $a_{43}$ | 0.279 | 20 | 55 | 20 | 5 | 0 |
| | | $a_{44}$ | 0.275 | 0 | 35 | 60 | 5 | 0 |

which should be built on the basis of single-layer evaluation model. The basic thought is as follows: first, it conducts single-layer comprehensive evaluation to he index at the most fundamental layer (or the bottom layer); then, by taking the evaluation results of this layer as the primary index of the upper layer, it evaluates the upper layer again and so forth to the highest layer.

Providing the secondary index comprehensive evaluation results are the elements, the fussy comprehensive evaluation matrix of the primary index is:

$$R = \begin{pmatrix} B_1 \\ B_2 \\ \cdots \\ B_m \end{pmatrix} = \begin{pmatrix} \Omega_1 \circ R_1 \\ \Omega_2 \circ R_2 \\ \cdots\cdots\cdots \\ \Omega_m \circ R_m \end{pmatrix}$$

Therefore, the fussy comprehensive evaluation of each object is:

$$B = \Omega \circ R = (\omega_1, \omega_2, \cdots, \omega_m) \circ \begin{pmatrix} \Omega_1 \circ R_1 \\ \Omega_2 \circ R_2 \\ \cdots\cdots\cdots \\ \Omega_m \circ R_m \end{pmatrix} = (b_1, b_2, \cdots, b_n)$$

Therefore, we can evaluate the objects in line with the value of $b_1$, $b_2$, … , $b_n$.

We can also divide the secondary indexes, to obtain the tertiary fussy comprehensive evaluation model or even the model with more layers. The multi-layer fussy comprehensive evaluation model can not only reflect the different layers of the evaluation index, but also avoid the difficulty in distributing weights because of too many indexes.

## EVALUATION EXAMPLES

According to the actual needs of evaluation decisions, the evaluation ranking standard can be divided into five classes, namely "excellent", "good", "medium", "qualified" and "disqualified".

v = {$v_1$, $v_2$, $v_3$, $v_4$, $v_5$} = {excellent, good, medium, qualified, disqualified} 100 people, including experts of the trade, management personnel of teaching, teaching supervisors and students are invited to evaluate and mark each index of teacher A's comprehensive quality in line with the defined evaluation ranking standards. The statistics results are shown as the Table 1.

According to Table 1, we can get the single-factor evaluation matrix of the secondary index as follows:

$$R_1 = \begin{pmatrix} 0.15\,0.57\,0.18\,0.10\,0 \\ 0.16\,0.68\,0.14\,0.02\,0 \\ 0.33\,0.61\,0.05\,0.01\,0 \\ 0.39\,0.58\,0.03\,0.00\,0 \\ 0.35\,0.63\,0.01\,0.01\,0 \end{pmatrix}, \quad R_2 = \begin{pmatrix} 0.15\,0.60\,0.18\,0.06\,0.01 \\ 0.31\,0.66\,0.02\,0.01\,0.00 \\ 0.43\,0.52\,0.04\,0.00\,0.01 \\ 0.41\,0.42\,0.12\,0.05\,0.00 \\ 0.87\,0.13\,0.00\,0.00\,0.00 \end{pmatrix}$$

$$R_3 = \begin{pmatrix} 0.75\,0.18\,0.07\,0.00\,0.00 \\ 0.84\,0.15\,0.01\,0.00\,0.00 \\ 0.34\,0.54\,0.10\,0.02\,0.00 \\ 0.86\,0.12\,0.02\,0.00\,0.00 \end{pmatrix}, \quad R_4 = \begin{pmatrix} 0.00\,0.10\,0.85\,0.10\,0.00 \\ 0.05\,0.40\,0.50\,0.05\,0.00 \\ 0.20\,0.55\,0.20\,0.05\,0.00 \\ 0.00\,0.35\,0.60\,0.05\,0.00 \end{pmatrix}$$

Therefore,

$B_1$ = (0.276,0.614, 0.082, 0.028,0)
$B_2$ = (0.43336, 0.46724, 0.07158, 0.04208, 0.00401)
$B_3$ = (0.70629, 0.23991, 0.08613, 0.00727,0)
$B_4$ = (0.0671, 0.3621, 0.5208, 0.061,0)
$B_5$ = (0.408713, 0.407651, 0.169202, 0.165074, 0.00 1195)

According to the maximum subordination principle, this teacher's comprehensive quality is excellent.

## CONCLUSION

Through the above mentioned analysis, we know that we can effectively evaluate nursing clinical teachers' comprehensive quality by utilizing analytic hierarchy method and fussy comprehensive evaluation method. Meanwhile, examples have proven that the evaluation is feasible, effective and easily to be accepted and promoted. This model and algorithm have rigorous logical reasoning and theoretical basis, thus providing brand new methods and means to teachers' comprehensive quality evaluation.

## ACKNOWLEDGMENT

This study is supported by the construct program of the key discipline in human province, Xiangnan University (XNU125KD031), China.

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