

The Research and Algorithm Design on Fuzzy Indicator of Teaching Evaluate System *

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CLC number TP31 Document code A Article ID 0529-6579 (2007) S2-0121-05

In order to improve the teaching evaluation effect, it is very significant to study the teachers evaluation indicator system and offer the algorithm of the evaluation methods.

The teachers evaluation indicator system includes two parts: one part is the solid indicator of the teaching activities, that is the fixed indicator; the other part is the Soft indicator of the teaching activities, that is the Fuzzy indicator. The solid indicator contains lessons, hours, achievements, etc. the Fuzzy indicator consists of teachers qualification, teaching methods, student understanding and satisfaction, etc., which can not be easily measured by fixed values. Fuzzy indicator holds an important position during teaching evaluation. Since there are no better indicator systems and quantified algorithm in higher education institutes these days, we will focus on studying the fuzzy indicator system here.

1 The establishment of the Fuzzy Indicator System

1.1 The teachers Evaluation Indicator

(1) The teachers quality Indicator

• Moral qualities

It includes responsibility on education, professional on the job, enthusiast with work and post, loving students, and be good examples of others.

• Academic qualities

In this part, it contains the modern education concept (it refers to paying attention to the needs of students, comprehensive development for students, cultivating the ability of study, carrying out the education policy completely, fostering students innovation, the notion of competition and cooperation, the idea of quality and benefit, the practice abilities); Scientific knowledge (this part includes knowledge on the major subject, the related subjects, experiences, and educa-

tional psychology); teaching ability (it involves abilities of planning and designing, organizing and managing, practicing, presentation, analysis and evaluation, comprehension and communication, scientific researching, and so on); and the Professional Development (it consists of skills, knowledge, potential, needs of being cultivated and expectation).

• Physically and mentally qualities

Extensive hobbies, enthusiast and sincere, respective, confident, improvement, Self control, consistent, democratic, equality, spirit of cooperation, Expectations and ideal, Patient and persisting.

(2) The Indicator of teachers responsibility

• Education and supervision responsibility

the work related to education object and spirit, the ideological and moral concern for students, To meet students demand of being respected, trusted and fairly treated, available when help needed from student.

• Teaching and research responsibility

• Organization of teaching environment (Atmosphere, classroom layout, and facility resource utilization).

Teaching (preparation and planning of lecture, adjustment among teaching methods, teaching objective and students needs, courses progress and continuity, achievement evaluation and monitoring, discipline); research (the adaptability between Research and teaching, Research and the development of the school, and research and selfdevelopment).

• Collaborative responsibility

Relationship (The relationship between teachers and students, teachers and teachers, teachers and parents, teachers and other departments, and teachers and external agencies); Administration (Participation in teaching and research group, in department, in school, and in other work).

收稿日期: 2007-10-28

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(3) The indicators of Teachers performance

- Education and management achievement

It is effective to infiltrate moral education through teaching from a excellent ethic and good moral character in the whole class. Students receive the respect, trust and fair treatment, meet students' needs of Comprehensive development.

- Teaching and research achievement

A good Teaching atmosphere, Teaching resources are fully and rationally developed and utilized, fully prepared, appropriate Teaching objective, appropriate Teaching methods, evaluate scientifically, Compliance with discipline, remarkable research results.

- Collaborative work achievement

harmonious Teaching relationship, smooth Working relationship, Participation related work in department, schools and other organizations.

Tab 1 Teacher evaluation indicator

No	Indicator	Weight	Value
1	Responsibility, Dedication, respecting your work and post and being good example	1.0	A 5 B 4 C 3 D 2 E 1
2	Educational concept, academic Qualification, teaching ability, Professional Development	1.0	A 5 B 4 C 3 D 2 E 1
3	Hobbies, Self control ability, Willpower, cooperation, Expectations and ideal, Patience and persisting	1.0	A 5 B 4 C 3 D 2 E 1
4	Teaching objective, Moral and care, To meet students needs of being trusted, respected and helped	1.0	A 5 B 4 C 3 D 2 E 1
5	involved in Teaching and research activities	1.0	A 5 B 4 C 3 D 2 E 1
6	Adaptability of teaching and research	1.0	A 5 B 4 C 3 D 2 E 1
7	cooperation with teachers, students, and the Ministry	1.0	A 5 B 4 C 3 D 2 E 1
8	infiltrate moral education through teaching, acquire the trust of Colleagues and students	1.0	A 5 B 4 C 3 D 2 E 1
9	Teaching atmosphere, the development and utilization of Teaching methods, and The research achievement	1.0	A 5 B 4 C 3 D 2 E 1
10	hamonious Teaching relationship, Working coordinately, participating related activities in colleges and schools	1.0	A 5 B 4 C 3 D 2 E 1

1.2 Student Evaluation Indicator

Student Evaluation Indicator is the items evaluated by students during the teacher Evaluation. More details in the table 2

Tab 2 Student Evaluation Indicators

No	Indicator	Weight Value	
1	the content is plentiful	1.2	A 5 B 4 C 3 D 2 E 1
2	the course is unambiguous	1.5	A 5 B 4 C 3 D 2 E 1
3	the course is logical	1.5	A 5 B 4 C 3 D 2 E 1
4	the key point is emphasized	1.2	A 5 B 4 C 3 D 2 E 1
5	The course is arranged in a reasonable time	0.9	A 5 B 4 C 3 D 2 E 1
6	The basic concept and the theory are explained clearly and precisely	1.5	A 5 B 4 C 3 D 2 E 1
7	theory is linked with practice in the course	1.2	A 5 B 4 C 3 D 2 E 1
8	teaching vividly and attractively in Mandarin	1.5	A 5 B 4 C 3 D 2 E 1
9	appropriately utilize various teaching methods (such as multimedia, a visual aid, writing on blackboard), and get a perfect performance	0.9	A 5 B 4 C 3 D 2 E 1
10	encourage students thinking, focus on students' learning ability	1.2	A 5 B 4 C 3 D 2 E 1
11	Properly use of professional English vocabulary	1.2	A 5 B 4 C 3 D 2 E 1
12	Formally dresses, full of spirit and enthusiasm	1.2	A 5 B 4 C 3 D 2 E 1
13	seriously prepared for lessons	1.5	A 5 B 4 C 3 D 2 E 1
14	begin and finish on time, and pay attention to discipline in classroom	0.9	A 5 B 4 C 3 D 2 E 1

1.3 Schools Evaluation Indicator

Schools Evaluation Indicator is the items evaluated by school in the teacher Evaluation. More details in table 3.

2 Fuzzy Indicators Evaluation Algorithm Design

2.1 Establish a Factor Set

Factor set consists of a set of various elements that affect the evaluation, indicated with U. There are three major elements in the Factor set of Fuzzy indicators evaluation: Teacher Evaluation overall indicator, Student Evaluation indicator and Schools Evaluation indicator. The factor set is given by

$$U(\text{Fuzzy indicator evaluation}) = \{ U_1(\text{Teacher Evaluation overall indicator}), U_2(\text{Student Evaluation indicator}), U_3(\text{Schools Evaluation indicator}) \}$$

Tab 3 Schools evaluation indicator

No	Indicator	Weight Value
1	Prepare lessons seriously, plentifully complete notes	1.5
2	Rigorous scholarship, well organization of the lecture outline, Counseling questions, testing practice and exercise, exertation, pay attention to students feedback	1.2
3	being good example for others, Strict enforcement of teaching discipline (never absent without notice)	1.2
4	follow course requirement, pay attention to the consistence in academic, scientific and advanced knowledge	1.5
5	The basic concepts and theories are explained clearly, emphasizing key points and Overcoming Difficulties	0.9
6	Link the theory with reality, enrich and update the teaching content	1.5
7	Make recondite knowledge easily understood, pay attention to develop the ability while initiating knowledge	1.2
8	Pay attention to the teaching methods, especially the utilization of modern teaching methods, encourage students' thinking, stimulate their studying interest	1.5
9	standard and fluent mandarin, normative Written, writing on blackboard orderly, With strong oral ability	1.2
10	Students can understand and grasp the basic theory, basic knowledge and basic skills of the course	0.9
11	Students can master Learning Method of the course	0.9
12	students improve the self learning ability by analyzing and solving problem through the course	0.9

U₁ (Teacher Evaluation overall indicator) includes the following 10 elements

U₁ Teacher Evaluation overall indicator = { a₁ (The ideological and moral qualities, a₂ (academic qualities, a₃ (Physical and mental qualities, a₄ (education and supervision responsibility, a₅ (Teaching and research responsibility, a₆ (Organization of learning environment, a₇ (Collaborative work responsibility, a₈ (Education and management achievement, a₉ (Teaching and research achievement, a₁₀ (Collaborative work achievement) };

U₂ (Student Evaluation indicator) includes the following 14 elements

U₂ (Student Evaluation indicator) = { b₁ (the content is plentiful, b₂ (the course is unambiguous, b₃ (the course is logical, b₄ (the key points is emphasized, b₅ (the course is arranged in a reasonable time, b₆ (the basic concept and theory are explained clearly and precisely, b₇ (theory is linked with practice in the course, b₈ (teaching vividly and attractively in Mandarin, b₉ (rationally use of various teaching methods, b₁₀ (encourage students thinking, focus on the learning ability of students, b₁₁ (Properly use of professional English vocabulary, b₁₂ (Formally dresses, full of spirit and enthusiasm, b₁₃ (seriously prepared for lessons, b₁₄ (begin and finish on time, and pay attention to discipline in classrooms) };

U₃ (Schools Evaluation indicator) includes the following 12 elements

U₃ (Schools Evaluation indicator) = { c₁ (Prepare lessons seriously, plentifully complete notes, c₂ (Rigorous scholarship, well organization of the lecture outline, Counseling questions, examination, And exertation, pay attention to students feedback, c₃ (being good example for others, Strict enforcement of teaching discipline (never absent without notice), c₄ (follow course requirement, pay attention to the consistence in academic, scientific and advanced knowledge, c₅ (The basic concepts and theories are explained

clearly emphasizing key points and Overcoming Difficulties,

6 (Link the theory with reality enrich and update the teaching content),

7 (Make recondit knowledge easily understood pay attention to developing the ability while initiating knowledge),

8 (Pay attention to the teaching methods especially the utilization of modern teaching methods encourage students' thinking stimulate their studying interest),

9 (standard and fluent mandarin normative Written writing on blackboard orderly With strong oral ability),

10 (Students can understand and grasp the basic theory basic knowledge and basic skills),

11 (Students can grasp Learning Method of the course),

12 (students improve the self learning ability by analyzing and solving problem through the course }

2.2 Establish a Weights Set

To reflect the importance of various factors, we endow various elements in the factor set with corresponding weights

$a_i (i=1, 2, \dots, 10)$ $b_i (i=1, 2, \dots, 14)$ $c_i (i=1, 2, \dots, 12)$ Usually the weights should be non-negative

$a_i \geq 0 (i=1, 2, \dots, 10)$ { the values of weight a_i are given in section 2.3.2 Table 2 }

$b_i \geq 0 (i=1, 2, \dots, 14)$ { the values of weight b_i are given in section 2.3.2 Table 3 }

$c_i \geq 0 (i=1, 2, 12)$ { the values of weight c_i are given in section 2.3.2 Table 4 }

we get the weight set

$A = \{ a_1, a_2, \dots, a_{10} \}$, $B = \{ b_1, b_2, \dots, b_{14} \}$, $C = \{ c_1, c_2, \dots, c_{12} \}$

2.3 Establish an Evaluation Set

Evaluation set consists of a set of various results given out by evaluators indicated with V. This system employs an Evaluation Set which is more comprehensive and more easily understood by students

$V = \{ A, B, C, D, E \}$

where $A(5)$, $B(4)$, $C(3)$, $D(2)$, $E(1)$, are respectively expressed as excellence, good, fair, pass, and fail

2.4 Factor Fuzzy Evaluation

Starting from a single factor, we can determine the

evaluation given by the evaluators towards this factor. It is also regarded as a fuzzy relationship between factor set U and evaluation set V.

Suppose that an evaluator is judging U_i based on the i element in factor set U, the evaluation results can be expressed by fuzzy set R_i

$R_i = \{ r_{i1}, r_{i2}, r_{i3}, r_{i4}, r_{i5} \} (i=1, 2, 5)$

For example the student evaluation indicator U_2 in the fuzzy indicators evaluation U is consisted of 14 items. When we evaluate item b_2 (the course is unambiguous), there are 30% for A, 20% for B, 20% for C, 20% for D, and 10% for E, respectively. The single factor evaluation set towards b_2 can be obtained as

$R_1 = \{ 0.3, 0.2, 0.2, 0.2, 0.1 \}$

Similarly we get the single factor evaluation set towards b_i

$R_1 = \{ r_{11}, r_{12}, r_{13}, r_{14}, r_{15} \}$ (the content is plentiful)

$R_2 = \{ r_{21}, r_{22}, r_{23}, r_{24}, r_{25} \}$ (the course is unambiguous)

$R_3 = \{ r_{31}, r_{32}, r_{33}, r_{34}, r_{35} \}$ (the course is logic)

$R_4 = \{ r_{41}, r_{42}, r_{43}, r_{44}, r_{45} \}$ (the key point is emphasized)

$R_5 = \{ r_{51}, r_{52}, r_{53}, r_{54}, r_{55} \}$ (The course is arranged in a reasonable time)

$R_6 = \{ r_{61}, r_{62}, r_{63}, r_{64}, r_{65} \}$ (The basic concept and theory are explained clearly and precisely)

$R_7 = \{ r_{71}, r_{72}, r_{73}, r_{74}, r_{75} \}$ (theory is linked with practice in the course)

$R_8 = \{ r_{81}, r_{82}, r_{83}, r_{84}, r_{85} \}$ (teaching vividly and attractively in Mandarin)

$R_9 = \{ r_{91}, r_{92}, r_{93}, r_{94}, r_{95} \}$ (Rationally use of various teaching methods)

$R_{10} = \{ r_{101}, r_{102}, r_{103}, r_{104}, r_{105} \}$ (encourage students thinking focus on the learning ability of students)

$R_{11} = \{ r_{111}, r_{112}, r_{113}, r_{114}, r_{115} \}$ (Properly use of professional English vocabulary)

$R_{12} = \{ r_{121}, r_{122}, r_{123}, r_{124}, r_{125} \}$ (Formally dressed full of spirit and enthusiasm)

$R_{13} = \{ r_{131}, r_{132}, r_{133}, r_{134}, r_{135} \}$ (seriously prepared for lessons)

$R_{14} = \{ r_{141}, r_{142}, r_{143}, r_{144}, r_{145} \}$ (begin and finish on time and pay attention to discipline in classrooms)

The Fuzzy Matrix is obtained from all single elements evaluation set of the student evaluation indicator U_2

$$R_B = \begin{bmatrix} r_{11} & r_{12} & r_{13} & r_{14} & r_{15} \\ r_{21} & r_{22} & r_{23} & r_{24} & r_{25} \\ r_{31} & r_{32} & r_{33} & r_{34} & r_{35} \\ r_{41} & r_{42} & r_{43} & r_{44} & r_{45} \\ r_{51} & r_{52} & r_{53} & r_{54} & r_{55} \\ r_{61} & r_{62} & r_{63} & r_{64} & r_{65} \\ r_{71} & r_{72} & r_{73} & r_{74} & r_{75} \\ r_{81} & r_{82} & r_{83} & r_{84} & r_{85} \\ r_{91} & r_{92} & r_{93} & r_{94} & r_{95} \\ r_{101} & r_{102} & r_{103} & r_{104} & r_{105} \\ r_{111} & r_{112} & r_{113} & r_{114} & r_{115} \\ r_{121} & r_{122} & r_{123} & r_{124} & r_{125} \\ r_{131} & r_{132} & r_{133} & r_{134} & r_{135} \\ r_{141} & r_{142} & r_{143} & r_{144} & r_{145} \end{bmatrix} \quad (1)$$

$$\begin{bmatrix} r_{11} & r_{12} & r_{13} & r_{14} & r_{15} \\ r_{21} & r_{22} & r_{23} & r_{24} & r_{25} \\ r_{31} & r_{32} & r_{33} & r_{34} & r_{35} \\ r_{41} & r_{42} & r_{43} & r_{44} & r_{45} \\ r_{51} & r_{52} & r_{53} & r_{54} & r_{55} \\ r_{61} & r_{62} & r_{63} & r_{64} & r_{65} \\ r_{71} & r_{72} & r_{73} & r_{74} & r_{75} \\ r_{81} & r_{82} & r_{83} & r_{84} & r_{85} \\ r_{91} & r_{92} & r_{93} & r_{94} & r_{95} \\ r_{101} & r_{102} & r_{103} & r_{104} & r_{105} \\ r_{111} & r_{112} & r_{113} & r_{114} & r_{115} \\ r_{121} & r_{122} & r_{123} & r_{124} & r_{125} \\ r_{131} & r_{132} & r_{133} & r_{134} & r_{135} \\ r_{141} & r_{142} & r_{143} & r_{144} & r_{145} \end{bmatrix} [5 \ 4 \ 3 \ 2 \ 1]^T \quad (2)$$

2.5 Fuzzy Overall Evaluation

Single element fuzzy evaluation reflects only the impact of One factor. Our objective is to consider the impact and importance of all the factors, and get a reasonable overall evaluation result. Imposing weights set B on all the factors in (1) with corresponding values $b_i \geq 0$ ($i=1, 2, \dots, 14$), all the factors in students evaluation indicators U_2 can be reflected. Thus, fuzzy overall evaluation can be expressed as

$$U_2 =$$
$$= RB \text{ EMBED Equation 3}$$
$$= [b_1 \ b_2 \ b_3 \ b_4 \ b_5 \ b_6 \ b_7 \ b_8 \ b_9 \ b_{10} \ b_{11} \ b_{12} \ b_{13} \ b_{14}] \circ R_B \circ R_B \circ \begin{bmatrix} 5 \\ 4 \\ 3 \\ 2 \\ 1 \end{bmatrix}$$

From (2), the fuzzy overall evaluation indicator of the student evaluation indicator U_2 in the fuzzy indicator evaluation set U can be obtained

It is similar for teacher overall evaluation indicator U_1 and school evaluation indicator U_3 , which is also a variable in the fuzzy indicator evaluation.

2.6 Fuzzy indicators evaluation formula

$$U = U_1 + U_2 + U_3 = A \circ R_A \circ [5 \ 4 \ 3 \ 2 \ 1]^T + B \circ R_B \circ [5 \ 4 \ 3 \ 2 \ 1]^T + C \circ R_C \circ [5 \ 4 \ 3 \ 2 \ 1]^T$$
$$\text{where}$$

$$A = \{a_1 \ a_2 \ a_{10}\}, \quad B = \{b_1 \ b_2 \ b_{14}\},$$
$$C = \{c_1 \ c_2 \ c_{12}\}$$

R_1 , R_2 and R_3 are respectively expressed as the Fuzzy Matrices of single factor evaluation of the teacher comprehensive evaluation indicator U_1 , the student evaluation indicator U_2 and school evaluation indicator U_3 .