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Research on the Evaluation Index System for Open University Faculty Based on FAHP

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Abstract: As a key platform serving lifelong learning for all citizens, faculty at open universities shoulder multiple responsibilities, including distance teaching, learning support, and career transition services. However, traditional faculty evaluation systems often suffer from unclear evaluation objectives, rigid indicator design, and subjective weight allocation. They particularly overlook the characteristics of distance education and the value of support services, making it difficult to fully reflect the faculty's actual contributions. To address these challenges, this study centers on developmental evaluation principles, integrating fuzzy mathematics with the Analytic Hierarchy Process (AHP) to construct a scientific evaluation system tailored to the teaching characteristics of open universities. It aims to overcome the evaluation pitfalls of "prioritizing research over service" and "emphasizing outcomes over processes," providing a systematic solution for faculty professional development and educational quality enhancement.

Keywords: Fuzzy AHP; Open University; Faculty evaluation

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1. Introduction

As the core vehicle for building a lifelong learning education system serving all citizens, teachers at open universities assume multiple roles: knowledge disseminators, learning facilitators, support providers, and career transition promoters [1]. Distinct from traditional universities, open education features a diverse student body (primarily working adults), remote teaching interactions, and vocationally oriented learning needs, imposing unique demands on teacher competency structures [2].

Current educational evaluation systems exhibit multiple shortcomings: Evaluation orientation is skewed, with excessive emphasis on quantifiable metrics like research output and publication counts, while qualitative indicators reflecting core educational values—such as instructional design innovation—are neglected. This fosters a tendency to "prioritize research over teaching and outcomes over processes." Evaluation dimensions are incomplete, largely replicating traditional university frameworks that fail to comprehensively cover the multidimensional competency matrix of "professional knowledge–distance teaching–support services–

personal attributes–social adaptability," resulting in insufficient assessment of critical service functions like learning guidance. Weighting assignments are subjective, with the relative importance of indicators determined by experience-based judgments, failing to scientifically address the ambiguity and uncertainty inherent in evaluation data, thereby undermining the objectivity and credibility of outcomes.

These shortcomings not only demotivate faculty but also constrain the continuous improvement of open education service quality. Therefore, there is an urgent need to establish a new evaluation system that aligns with the institutional positioning of open universities, reflects the unique role of faculty, and combines scientific rigor with practical applicability. This study introduces the Fuzzy Analytic Hierarchy Process (FAHP) to address the ambiguity in determining indicator importance, scientifically quantify the weights of each dimension, and validate its effectiveness through empirical application. This provides a theoretical basis and practical tool for the professional development of open university faculty and the enhancement of educational quality.

2. Theoretical foundation and research design

2.1. Theoretical applicability of Fuzzy Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) resolves multi-criteria decision problems by constructing hierarchical models and judgment matrices. However, when applied to domains involving substantial subjective judgments—such as faculty evaluation—traditional AHP requires experts to provide precise numerical assessments (e.g., on a 1–9 scale), which struggles to accurately capture the inherent fuzziness of human cognition [3]. FAHP, by incorporating fuzzy mathematics theory, permits experts to use fuzzy language (e.g., "slightly important," "significantly important") or fuzzy numbers for judgments, better aligning with real-world decision-making [4].

2.2. Fuzzy judgment matrix

In fuzzy AHP, pairwise comparisons between factors are quantified by the degree to which one factor is more important than another. This yields a fuzzy judgment matrix $A = (a_{ij})_{n\times n}$, which represents the original input data matrix, as shown in Matrix (1):

$$\begin{pmatrix} 0.5 & a_{12} & a_{13} & \cdots & a_{1n} \\ a_{21} & 0.5 & a_{23} & \cdots & a_{2n} \\ a_{31} & a_{32} & 0.5 & \cdots & a_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & a_{n3} & \cdots & 0.5 \end{pmatrix} \quad \text{Matrix (1)}$$

It possesses the following properties:

n×n order, with all values between 0.1 and 0.9; higher values indicate greater importance

$$a_{ii} = 0.5, \forall i \in N$$

$$a_{ij} + a_{ji} = 1, a_{ij} \geq 0, \forall i, j \in N(i \neq j)$$

2.3. Data scaling

Data scaling describes the relative importance between paired factors, as shown in **Table 1** below.

Table 1. Data scaling table [5]

Scale	Definition	Description
0.5	Equally important	When comparing two elements, they are equally important
0.6	Slightly more important	When comparing two elements, one is slightly more important than the other
0.7	Significantly more important	When comparing two elements, one is significantly more important than the other.
0.8	Much more important	When comparing two elements, one is significantly more important than the other.
0.9	Extremely important	When comparing two elements, one is extremely more important than the other
0.1, 0.2, 0.3, 0.4	Reverse comparison	If comparing element ai with element aj yields judgment Rij(,), then comparing element aj with element ai yields judgment Rji = 1 - Rij

2.4. Weight calculation

For a fuzzy complementary judgment matrix, the formula (1) for calculating the weights of the judgment matrix is as follows:

$$W_i = \frac{\sum_{j=1}^{n} a_{ij} + \frac{n}{2} - 1}{n(n-1)}, i \in N2.5 \quad \text{Formula (1)}$$

The weight values obtained using the above formula (1) require consistency verification, which is performed using the compatibility principle of the fuzzy judgment matrix. Applying the above equation yields the weight vector $W = (W_1, W_2, ..., W_n)^T$ for the fuzzy judgment matrix A, where $\sum_{i=1}^{n} W_i = 1, W_i \geq 0 (i \in N)$.

Constructing feature matrix elements, Formula (2):

$$W_{ij} = \frac{W_i}{W_i + W_j}, \forall i, j \in n \quad \text{Formula (2)}$$

Then, the feature matrix of judgment matrix A is given by formula (3):

$$W = (W_{ij})_{n \times n} \quad \text{Formula (3)}$$

For the decision-maker's attitude α, when satisfying formula (4):

$$I(A, W) = \frac{1}{n^2} \sum_{i=1}^{n} \sum_{j=1}^{n} \left| a_{ij} + W_{ji} - 1 \right| \leq \alpha \quad \text{Formula (4)}$$

The judgment matrix is then deemed satisfactory and consistent. The smaller the value of α, the higher the decision-maker's requirement for consistency in the fuzzy judgment matrix. Typically, $\alpha = 0.1$ is recommended.

3. Construction of a multidimensional evaluation index system for open university faculty

3.1. Principles for indicator design

(1) Developmental principle: The evaluation system aims to promote faculty professional growth. Through diagnosis, feedback, and improvement, it motivates self-enhancement rather than serving solely for rewards or punishments. It should dynamically reflect faculty development and provide personalized growth recommendations.

(2) Open education adaptability principle: Tailored to the characteristics of open universities, the evaluation system must emphasize core competencies such as distance teaching, support services, and social connectivity. Indicator design should reflect the interactivity, career orientation, and student diversity

inherent in distance education.

(3) Operability principle: Indicator definitions must be clear, observation points specific, and data collection convenient. Design should balance theory and practice to ensure evaluations are genuinely feasible, avoiding abstract or difficult-to-quantify metrics.

(4) Systematic principle: The evaluation system must comprehensively cover all faculty responsibilities. Each dimension should be independent yet organically interconnected, forming a complete framework. It should holistically assess faculty capabilities, avoiding undue emphasis on any single dimension to ensure comprehensive and accurate evaluation.

3.2. Structure of the indicator system

Through literature review, policy interpretation (e.g., the requirement to eliminate the "five sole criteria" in the "Overall Plan for Deepening Education Evaluation Reform in the New Era"), and two rounds of Delphi expert consultation (expert authority coefficient > 0.8), a multidimensional evaluation system comprising 5 primary indicators and 13 secondary indicators was ultimately established (**Table 2**).

Table 2. Open university faculty evaluation indicator system and FAHP weight distribution results

Primary indicators	Secondary indicators	Indicator definition
Professional Knowledge (PK)	Disciplinary Knowledge (**PK_1**)	Mastery of course content and awareness of disciplinary frontiers
	Academic Output (**PK_2**)	Publication quantity and quality, research project participation [6]
Distance Learning (DT)	Instructional Design (DT_1)	Rationality of course planning and preparation of teaching resources[7]
	Teaching implementation (DT_2)	Teaching method diversity and classroom interaction [8]
	Teaching Feedback (DT_3)	Timeliness of student assignment grading, tracking of learning outcomes
Support Services for Teaching (ST)	Learning Support (ST_1)	Timeliness of online Q&A, provision of learning resources[9]
	Psychological Counseling (ST_2)	Capacity for identifying and intervening in student psychological issues
	Vocational Education Integration (ST_3)	Industry certification alignment (linking courses to professional qualifications), lifelong learning pathway planning
Personal Traits (PT)	Professional Ethics (**PT_1**)	Teacher ethics and professional conduct
	Work Attitude (**PT_2**)	Teaching commitment and sense of responsibility [10]
	Teamwork (**PT_3**)	Collaboration with colleagues, team contribution
Social Adaptability (SA)	Continuing Education (**SA_1**)	Personal commitment to ongoing learning and development
	Industry Connections (**SA_2**)	Collaboration with industry enterprises and industry influence

4. Determination of evaluation indicator weights based on FAHP

4.1. Construction of fuzzy complementary judgment matrix

Fifteen experts familiar with open education were invited to conduct pairwise importance comparisons of indicators across levels using a 0.1–0.9 scale. The resulting fuzzy complementary matrix is shown in **Table 3**.

Table 3. Fuzzy complementary R matrix

Item	PK_1	PK_2	DT_1	DT_2	DT_3	ST_1	ST_2	ST_3	PT_1	PT_2	PT_3	SA_1	SA_2
PK_1	0.5	0.7	0.4	0.2	0.3	0.4	0.5	0.7	0.1	0.2	0.7	0.7	0.5
PK_2	0.3	0.5	0.2	0.1	0.2	0.3	0.3	0.5	0.1	0.1	0.5	0.5	0.3
DT_1	0.6	0.8	0.5	0.4	0.5	0.5	0.6	0.7	0.1	0.2	0.7	0.6	0.6
DT_2	0.8	0.9	0.6	0.5	0.6	0.6	0.7	0.8	0.1	0.3	0.8	0.7	0.8
DT_3	0.7	0.8	0.5	0.4	0.5	0.5	0.6	0.7	0.1	0.2	0.7	0.6	0.7
ST_1	0.6	0.7	0.5	0.4	0.5	0.5	0.6	0.6	0.1	0.2	0.7	0.6	0.6
ST_2	0.5	0.7	0.4	0.3	0.4	0.4	0.5	0.6	0.1	0.1	0.7	0.6	0.5
ST_3	0.3	0.5	0.3	0.2	0.3	0.4	0.4	0.5	0.1	0.1	0.5	0.5	0.3
PT_1	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.5	0.6	0.9	0.9	0.9
PT_2	0.8	0.9	0.8	0.7	0.8	0.8	0.9	0.9	0.4	0.5	0.8	0.8	0.8
PT_3	0.3	0.5	0.3	0.2	0.3	0.3	0.3	0.5	0.1	0.2	0.5	0.4	0.3
SA_1	0.3	0.5	0.4	0.3	0.4	0.4	0.4	0.5	0.1	0.2	0.6	0.5	0.3
SA2	0.5	0.7	0.4	0.2	0.3	0.4	0.5	0.7	0.1	0.2	0.7	0.7	0.5

For example, experts generally agree that the importance scale mean for "Subject Knowledge (PK1)" is 0.7 compared to "Academic Achievements (PK2)," indicating that in the context of open universities, subject knowledge capabilities are significantly more important than the output of academic achievements.

4.2. Weight calculation results

Based on the FAHP weight calculation, the weight distribution results for each primary indicator and representative secondary indicators in the Open University faculty evaluation indicator system are obtained, as shown in **Table 4** below.

Table 4. FAHP weight results

Item	Disciplinary knowledge	Academic achievements	Instructional design	Teaching implementation	Teaching feedback	Learning support
Weighting	7.88%	6.52%	8.48%	9.39%	8.56%	8.33%
Item	Psychological counseling	Vocational education integration	Professional ethics	Work attitude	Teamwork	Continuing education
Weighting	7.80%	6.89%	11.44%	10.68%	6.74%	7.27%

Personal traits carry significant weight, with professional ethics (11.44%) and work attitude (10.68%) being the most prominent, reflecting a strong emphasis on teachers' personal qualities and professional conduct. In remote teaching, instructional implementation (9.39%) holds the highest weight, followed closely by instructional feedback (8.56%) and instructional design (8.48%), highlighting the importance of teaching quality and student learning experiences. Regarding support services, learning support (8.33%) carries significant weight, while psychological counseling (7.80%) and vocational education integration (6.89%) also hold notable proportions, reflecting attention to learning resources and mental health. Within professional knowledge, subject

expertise (7.88%) and academic achievements (6.52%) have relatively lower weights but remain integral components of the evaluation framework. Continuing education for social adaptability (7.27%) holds moderate weight, encouraging faculty to pursue ongoing learning and adapt to change.

4.3. Consistency test

This study employed the compatibility ratio (CR) from fuzzy judgment matrices for consistency testing. When the CR value falls below the preset threshold (typically 0.1), the judgment matrix is deemed consistent, as shown in **Table 5**.

Table 5. Consistency verification results

Indicator	Value	Judgment criteria	Judgment result
Consistency check CR index	0.0858	<0.1	Pass

Table 5 shows that the consistency ratio (CR) value is 0.0858, significantly below the 0.1 threshold. This indicates a high degree of consistency in experts' judgments regarding the importance of indicators, with scientifically sound weight allocation. This ensures the credibility and reliability of the evaluation system, providing effective support for faculty evaluation and professional development at the Open University.

5. Conclusion

This study addresses issues in Open University faculty evaluation—such as single-dimensional indicators, subjective weighting, and inadequate reflection of distance education characteristics—by innovatively introducing the FAHP. It constructs a multidimensional evaluation system encompassing five dimensions: professional knowledge, distance teaching, support services, personal traits, and social adaptability. Through the fuzzy complementary judgment matrix and consistency test (CR = 0.0858 < 0.1), the logical rigor of expert judgments and the scientific nature of weight allocation were validated. Empirical research demonstrates that this system significantly enhances the evaluation precision of key attributes such as faculty members' distance teaching implementation capabilities, learning feedback efficiency, and professional adaptability. It accurately identifies the areas of strength for different faculty members across each dimension, providing differentiated guidance for faculty professional development. Concurrently, the weighting allocation underscores open education's emphasis on teaching practice capabilities (over 26% weight) and professional ethics (11.44%), effectively guiding educators to shift focus from "research-centric" to "teaching and service-oriented" practices.

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