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Article

Research on Artificial Intelligence Technical Support of WSR Methodology in Performance Management of English Teachers in Colleges and Universities

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Abstract: Performance management evaluation of university English teachers is of great significance for improving the current status of English teachers' capabilities, and the relative importance of evaluation indicators is a prerequisite for ensuring the accuracy of evaluation results. This article is based on the WSR system methodology, incorporating artificial intelligence technology into its causal framework factors, and utilizing research projects for quantification to construct a performance management model for university English teachers. Based on this, an evaluation indicator system for the performance management of university English teachers was established, and a comprehensive evaluation model for English teacher performance management was developed using entropy weighting and grey relational analysis. To further explore the factors influencing the performance management level of university English teachers, the fsQCA method was introduced to conduct a configurational analysis of English teacher performance management. The study found that the "logic" component in the WSR system methodology has a greater influence (with a weight value of 0.3458), and the comprehensive score for the performance management level of university English teachers in the selected cases fluctuated between 0.32 and 0.87 points. There are two configuration paths to promote high-performance management levels among university English teachers, both of which highlight the importance of research capabilities, specifically the efficient application of artificial intelligence (AI) technology. Therefore, university English teachers need to expand the application of AI technology and accelerate the intelligent reform of English teaching to achieve the development of high-performance management levels.

Keywords: artificial intelligence; entropy weight method; grey relational analysis; fsQCA method; performance management

1. Introduction

In the knowledge economy era, competition among businesses has gradually shifted from capital-based competition to talent-based competition. To attract a sufficient number of high-quality talents, many companies have established corresponding human resources systems, aiming to gain a competitive edge in talent acquisition through measures such as generous compensation, comprehensive benefits, and diverse employee activities, yet they have overlooked the impact of performance management [1-4]. As an integral part of human resources, performance management is crucial for employee motivation and retention. A well-established performance management system is closely linked to talent acquisition and retention [5-6]. From the initial formula-based calculations to the current performance evaluations aligned with corporate strategic goals, every aspect underscores the importance

of performance management [7-8]. Similarly, the significance of performance management systems is also evident in educational and training systems.

Teacher performance management is an indispensable part of higher education, aimed at continuously motivating teachers, promoting their professional development, and providing students with higher-quality teaching services [9-10]. Additionally, scientific and reasonable performance evaluations directly impact teacher compensation management and promotions, influencing teachers' work enthusiasm, initiative, and creativity, which in turn affects the quality of teaching and services provided by the school [11-13]. Therefore, a scientific and reasonable performance evaluation system is an urgent issue that needs to be addressed in the human resources management of private schools.

Due to the complex nature of English teachers' work, which involves long hours and a high degree of time sensitivity, it is relatively difficult to measure their performance [14]. Therefore, constructing a performance evaluation system for university English teachers based on artificial intelligence technology can clarify objectives, methods, and the procedures for distributing performance-based wages [15-16]. Additionally, the "Physical-Moral-Human" (WSR) methodology is introduced to further consider the impact of humanistic and social environments on the subjective initiative of English teachers, aiming to enhance teachers' work enthusiasm [17-19].

How to implement a reasonable performance management system for university English teachers to fully highlight their achievements in teaching, research, and serving society is a critical issue that the current performance management system for university English teachers must address. First, the WSR system methodology and analysis matrix are discussed, and the rational framework is used to transform artificial intelligence technology into English teachers' research projects, thereby constructing a performance management model and evaluation indicator system. Second, the entropy weight method is employed to determine the weights of evaluation indicators, and gray relational analysis is combined to construct a comprehensive performance management evaluation model for English teachers. Additionally, the fsQCA method is utilized to explore the factors influencing the performance management level of university English teachers. Finally, using 20 English teachers from universities in different regions as examples, the weights of physical, rational, and human factors under the WSR framework and their comprehensive performance management scores are analyzed. Additionally, the fsQCA method is used to analyze the configuration paths of performance management for university English teachers.

2. Building a Performance Management System for College English Teachers

Performance management and evaluation of university English teachers is an important component of university administration, yet it also presents significant challenges. As the scale of higher education enrollment continues to expand, there has been increasing attention on higher education and scrutiny of universities, leading to a growing body of research on the performance evaluation of university English teachers. However, current performance evaluation systems for university English teachers often exhibit issues such as prioritizing rewards over development and research over teaching. These phenomena have, to varying degrees, dampened the work enthusiasm of university English teachers and hindered the healthy development of universities. Therefore, it is imperative to address the issue of performance management and evaluation for university English teachers, to look beyond the surface phenomena and uncover the underlying substantive issues, and to seek solutions from the root cause.

2.1. WSR System Methodology Foundation

2.1.1. WSR System Method Theory

Physical-Moral-Human (WSR) is an Eastern systems methodology proposed by Professor Gu Jifa during discussions with Professor Yoshikazu Shiraki of Japan and Dr. Zhu Zhichang, a Chinese PhD graduate from the UK. WSR represents the application of Chinese systems thinking and the philosophical concept of "unity of heaven and humanity" in modern management. The International Society for Systems Science (ISSS) has classified the WSR system methodology as an "integrated system methodology." The "Eastern Systems Research" project, centered on WSR, has received multiple sponsorships from the International Federation for Systems Research (IFSR).

The core idea of WSR is that when dealing with complex issues, one must fully consider the operational mechanisms of "things," comprehensively analyze the arrangements and operational rules of "matters," and combine the optimal processing procedures of "people." This is a systematic methodology for comprehensively addressing complex issues, emphasizing the holistic and hierarchical nature of matters [20]. The dynamic unity of the material world, system organization, and human factors serves as the guiding principle for the practical application of the WSR system methodology, encapsulated in the motto "understand the physical, grasp the rational, and comprehend the human." The implementation

process of the WSR system methodology typically involves seven steps: understanding the intent, setting objectives, conducting investigations and analyses, constructing strategies, selecting solutions, coordinating relationships, and realizing the vision. Currently, the WSR system methodology is widely applied in fields such as environmental governance, brand sales channel construction, data governance, resource security system construction, tourism development model analysis, and manufacturing enterprise service capabilities. Some scholars have begun to explore the application of WSR in the education sector, such as using WSR to study teacher performance management. Through continuous refinement, WSR has become a representative of Eastern system methodologies.

This paper constructs a performance management evaluation system for university English teachers from a WSR perspective, reveals the constituent elements and relationships of the performance management system for university English teachers, analyzes development challenges, and proposes improvement strategies, aiming to provide theoretical references and practical guidance for enhancing the effectiveness of performance management for university English teachers.

2.1.2. WSR System Analysis Matrix

Following the WSR system methodology, the performance management system for university English teachers is systematized and hierarchical. Each subsystem and element is analyzed from three dimensions: "physical, factual, and human." The specific process can be described using a matrix.

(1) Divide the system into a set of subsystems. Divide the performance management system for college English teachers into n subsystems according to certain rules. Let the set of subsystems be A and $A=(a_1,a_2,...,a_n)a_i$ be the i th subsystem of the system.

(2) Determine the dimension analysis matrix. Based on the preliminary analysis of the "physical," "logical," and "human" aspects of the university English teacher performance management system, and in combination with actual conditions and specific environments, the Delphi method is used to determine the variables affecting the subsystems from the three dimensions of physical, logical, and human, and these are described using a dimension analysis matrix. That is:

$$B=(b_{ij})_{3xm}=\begin{Bmatrix} b_{11} & b_{12} & b_{13} & \cdots & b_{1m} \\ b_{21} & b_{22} & b_{23} & \cdots & b_{2m} \\ b_{31} & b_{32} & b_{33} & \cdots & b_{3m} \end{Bmatrix} \tag{1}$$

The elements in B and $b_{ij}(i=1,2,3;j=1,2,...,m)$ represent the changing factors that affect subsystem a_i of system A from different dimensions, such as "physical," "logical," and "human," including teaching standards, technical capabilities, and the level of educational reform.

(3) Construct a system analysis matrix. Based on the above A and B matrices, the performance management system for university English teachers R can be represented in matrix form as follows:

$$R=(a_1B,a_2B,...,a_nB)^T \tag{2}$$

Among them, a_iB represents the i th subsystem of the college English teacher performance management system R analyzed by the WSR system, and a_ib_{ij} represents the j th element analyzed from a specific dimension among the three dimensions of physical, factual, and human dimensions in the i th subsystem.

2.2. Performance Management System Based on WSR

2.2.1. Teacher Performance Management Model

It is essential to integrate knowledge, methods, and tools from various fields such as natural sciences, management sciences, humanities, and social sciences, continuously understanding and grasping the objective laws of social development, to provide a solid scientific theoretical foundation for the Scientific Development Outlook. The application of the WSR system methodology to the performance management system for university English education primarily involves three factors: physical, rational, and human. The specific framework is shown in Figure 1. The physical factor forms the foundation of the system, while the rational factor refers to the methods and approaches adopted to achieve the system's objectives, serving as the means for English education performance management. The human factor

plays a dominant role in the system, acting as the subject of research into physical and rational factors, while also being the object served by these factors. In the practice of English teacher performance management, one can identify issues with physical factors, use rational means to understand and resolve these issues, and also improve rational factors through practice to enhance problem-solving efficiency. University English teacher performance management can only be fully and effectively implemented by taking scientific physical factors as the foundation, reliable rational factors as the means, and flexible human factors as the dominant element.

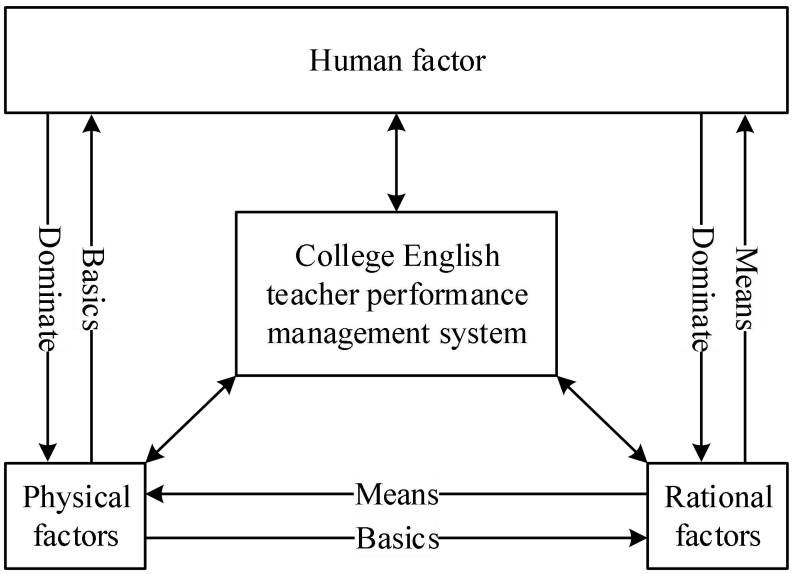

Figure 1. English Teacher Performance Management Model.

2.2.2. Teacher Performance Management System

Based on the performance management model for university English teachers constructed in the preceding section, this paper argues that the evaluation of university English teacher performance management should be objective, comprehensive, and fair, thereby reflecting the level of performance management for university English teachers. From three dimensions—physical, rational, and human—a performance management evaluation system for university English teachers has been constructed, as shown in Table 1. Physical factors primarily include teaching workload, teaching quality, and teaching reform achievements. Rational factors primarily include research awards, published works, and research projects. Human factors primarily include teaching and educational capabilities, professional ethics, and personal character.

Table 1. English Teacher Performance Management system.

Dimension	Content	Code
Physical factor	Teaching workload	W1
	Teaching quality level	W2
	Teaching reform results	W3
Reasoning factor	Teacher research award	S1
	The teacher is published	S2
	Teacher research project	S3
Human factor	Teaching education	R1
	Professional ethics	R2
	Teacher personality	R3

3. Performance Management Evaluation Model for College English Teachers

In the development of artificial intelligence, the role of performance management for university English teachers is particularly prominent. Through scientific performance evaluation and management, it is possible to effectively improve the work performance of English teachers and enhance the quality of English teaching. However, most universities currently still rely on traditional performance management

methods, which are disconnected from their strategic goals and hinder the scientific management and healthy development of university English teachers. Therefore, exploring the issue of performance management for university English teachers is of critical importance.

3.1. Evaluation Model for Teacher Performance Management

3.1.1. Method for Solving Indicator Weights

Entropy Weighting Method (EWM) is an objective weighting method. By measuring and evaluating the entropy values between indices, the overall dispersion among indices can be determined. Dispersion is inversely proportional to the entropy values within the indices and directly proportional to the comprehensive weights of the indices. In the process of information acquisition and measurement, the information entropy analysis tool can be used to calculate the average weights of the indices being measured, thereby determining the comprehensive weights of each indicator [21]. The specific steps are as follows:

(1) Data standardization. Before proceeding with subsequent computational steps, it is necessary to preprocess the collected data to ensure the accuracy and comparability of the assessment results. This paper employs the range transformation method, processing the indicator data through range transformation to make the data more accurate and easier to compare, thereby providing robust support for subsequent analysis and decision-making.

The processing of positive indicators is as follows:

$$X_{ij}^{'} = \frac{x_{ij} - \min\{x_{1j}, x_{2j} \ldots\ldots x_{Nj}\}}{\max\{x_{1j}, x_{2j} \ldots\ldots x_{Nj}\} - \min\{x_{1j}, x_{2j} \ldots\ldots x_{Nj}\}} + c \tag{3}$$

The handling of negative indicators is as follows:

$$X_{ij}^{'} = \frac{\max\{x_{1j}, x_{2j} \ldots\ldots x_{Nj}\} - x_{ij}}{\max\{x_{1j}, x_{2j} \ldots\ldots x_{Nj}\} - \min\{x_{1j}, x_{2j} \ldots\ldots x_{Nj}\}} + c \tag{4}$$

(2) Calculate the proportion of the sample values of i under the j index to the sum of all sample values of the index P_{ij}. In statistics and data analysis, formulas are often used to calculate the numerical values of various indicators. These metrics can be used to assess and compare differences between different samples. The commonly used formula is the numerator is the normalized value of the i sample value under the i index, and the denominator is the sum of all the sample values under the j index, and the standardized formula is as follows:

$$P_{ij} = \frac{x_{ij}^{'}}{\sum_{i=1}^{n} x_{ij}^{'}} (i = 1, 2, 3, \ldots, n; j = 1, 2, 3, \ldots, m) \tag{5}$$

(3) Calculate the information entropy e_j of the j th indicator. When calculating information entropy, it is necessary to ensure that p_{ij} is greater than 0, so $X_{ij}^{'}$ used to calculate p_{ij} cannot be 0. However, after the above standardization process, $X_{ij}^{'}$ may have a value of 0, so it is necessary to perform a translation transformation on the 0 value. The calculation formula is as follows:

$$e_j = -k \sum_{i=1}^{n} p_{ij} \ln(p_{ij}) \tag{6}$$

$$k > 0, k = \frac{1}{\ln(m)} (0 \le e_j < 1) \tag{7}$$

(4) Calculate the information entropy redundancy d_j. The smaller the entropy value, the more information the indicator carries; conversely, the larger the entropy value, the less information the indicator carries. Therefore, the entropy value calculated in the third step is inversely proportional to the

information content. The calculation logic for this step is to subtract the entropy value from 1, representing the useful information content. The calculated indicator can be referred to as the information entropy redundancy, denoted by d_j. The formula is as follows:

$$d_j = 1 - e_j \tag{8}$$

(5) Calculate the evaluation indicator weight w_j. Using information entropy redundancy to determine the weight of an indicator is an effective method for quantifying and measuring the importance of an indicator. The higher the degree of correlation between an indicator and other indicators, the more important it is for describing the characteristics of the dataset, and therefore it should be assigned a higher weight. The weight of each indicator can be obtained by calculating the ratio of the indicator's information entropy redundancy to the sum of the information entropy redundancy of all indicators. The sum of the indicator weights is 1. The calculation formula is as follows:

$$w_j = \frac{d_j}{\sum_{j=1}^{m} d_j} (j = 1, 2, 3, ..., m) \tag{9}$$

3.1.2. Gray Correlation Evaluation Model

In grey system theory, grey correlation analysis seeks to determine the strength and magnitude of relationships between subsystems (or factors) within a system by examining the geometric shapes of the change curves of various factors. If the subsystems exhibit consistent trends as reflected in the sample data, then their correlation is considered strong. Conversely, if the trends are inconsistent, the correlation is considered to be relatively weak. This analytical method does not require data to exhibit regular patterns and can evaluate data with different physical meanings within the same sample system. Therefore, gray correlation analysis can measure the developmental trends of a system, provide quantitative metrics, and offers certain advantages in dynamic process analysis. When conducting actual evaluations, the data of the samples to be evaluated must first be normalized. Then, the correlation coefficients between samples are calculated, followed by correlation analysis. Finally, the samples are ranked based on the magnitude of their correlation, as outlined in [22]. The specific calculation steps of the performance evaluation model for college English teachers established in this paper are as follows:

(1) Determine the analysis sequence. Assume that the set of multi-criteria decision domains for teachers is A_i ={Teacher 1, Teacher 2, ⋯, Teacher m}= $\{A_1, A_2, \cdots, A_m\}$, and the set of evaluation criteria for teacher performance is $V_j = (v_1, v_2, \cdots, v_n)$ Then, let the attribute values of the decision set A_i for the indicator set A_j be denoted as $X_{ij}(i = 1, 2, \cdots, m, j = 1, 2, \cdots, n)$, where X_{ij} is the value of the j th evaluation indicator for the i th evaluation object.

(2) Dimensionless processing of sample data indicators. Let the evaluation indicators of the teacher with the best performance A_0 be X_{0j}. According to the characteristics of the indicators, the evaluation indicators are divided into three types: cost-type, benefit-type, and moderation-type indicators. When V_j is a cost-type indicator, the optimal value is the minimum value, i.e., $X_{0j} = \min(X_{1j}, X_{2j}, \cdots, X_{nj})$ When V_j is a benefit-type indicator, the optimal value is the maximum value among all data points, i.e., $X_{0_j} = \max(X_{1j}, X_{2j}, \cdots, X_{nj})$. When V_j is a moderation indicator, the optimal value is moderate, i.e., $X_{0j} = X_{nj}$. Let:

$$X_{ij}^{'} = x_{ij} / x_{0j} (i = 1, 2, \cdots, m, j = 1, 2, \cdots, n) \tag{10}$$

The dimensionless matrix obtained through the above processing is as follows:

$$X_{0j}^{'} = [1, 1, \cdots, 1], X_{ij}^{'} = \left[X_{i1}^{'}, X_{i2}^{'}, \cdots, X_{in}^{'} \right] \tag{11}$$

Thus, the augmented matrix that will contain the relative optimal set, i.e.,:

$$X = (x_{ij})_{(m+1)n} (i = 0,1,\cdots,m,\ j = 1,2,\cdots,n) \tag{12}$$

It is called the decision matrix of the set of programs A on the indicator V.

(3) Gray correlation coefficient operation.Teachers to be evaluated indicator data and the gray correlation of the optimal sequence of data obtained above needs to be calculated step by step, need to calculate the gray correlation coefficient of teachers to be evaluated indicator data and the optimal sequence of data.The specific calculations are as follows:

Let the correlation coefficient of the j indicator value of the i teacher be ξ_{ij}, then the maximum absolute difference of each indicator is:

$$\Delta_{\max} = \max_i \max_j | x_{ij}^{'} - x_{0j}^{'} | \tag{13}$$

The minimum absolute error for each indicator is:

$$\Delta_{\min} = \max_i \max_j | x_{ij}^{'} - x_{0j}^{'} | \tag{14}$$

The correlation coefficient is obtained from the maximum and minimum absolute errors:

$$\xi_{ij} = \frac{\Delta_{\min} + \rho\Delta_{\max}}{\Delta_{ij} + \rho\Delta_{\max}} \tag{15}$$

where $\Delta_{ij} = | x_{ij}^{'} - x_{0j}^{'} |$, and $\rho \in (0,\infty)$ is called the resolution factor.The numerical magnitude of the resolution coefficient is inversely proportional to the resolving power, and the resolution coefficient generally takes values within (0,1), which can be determined on a case-by-case basis.

3.2. Qualitative Comparative Analysis Methods for Fuzzy Sets

3.2.1. Theory of fsQCA Methodology

Qualitative Comparative Analysis (QCA) has its origins in comparative sociology and political science and is a mixed-methods research methodology, an analytical approach based on the logic of set-theoretic Boolean algebra realizing the principles of case comparison, which is often used in qualitative research.The method enables researchers to compare empirical cases and outline the conditions under which their presence or absence moderates the presence or absence of particular outcomes.

QCA identifies logically simplified statements that represent different conditional groupings of particular outcomes, there are three main variants of QCA, namely clear set QCA (csQCA), multi-valued set QCA (mvQCA) and fuzzy set QCA (fsQCA), which is used in this paper for fuzzy set qualitative comparative analysis.

The fsQCA is a case-comparison based research methodology, which means that it outlines the recurring patterns of conditions in observed cases and assesses their correlation with defined outcomes [23].By outlining how multiple attributes can be combined into different configurations to produce the outcome of interest, assessing whether multiple groupings are linked to the same outcome and the relative empirical importance of each configuration, this method is best suited for exploring complex interactions. fsQCA has one of its main strengths in that it provides detailed information on the different patterns of conditions across cases in a given sample.This makes fsQCA suitable for studying complex phenomena where the presence or absence of certain specific conditions may affect the service experience differently, and using fsQCA it is possible to explore the conditions that are necessary and sufficient to improve satisfaction.Therefore, through fsQCA it is possible to shift the focus of the research from the study of "critical success factors" to "critical paths to success", which follows the assumption of a symmetrical relationship between the key variables.In addition, fsQCA can be used to analyze both quantitative and qualitative data, and despite the benefits of fsQCA, the results of the study are limited to the case under study, so the method is not intended to test the overall effect, but rather to explore and explain how different factors may lead to specific outcomes.

3.2.2. fsQCA Methodology Steps

Figure 2 shows the specific operation flow of fsQCA, which mainly includes the steps of defining variables, variable calibration, necessity test, truth table generation, group analysis, robustness test and

result interpretation.The details are as follows:

(1) Define variables.Firstly, the research question is clarified and key explanatory variables and outcome variables are identified.

(2) Variable calibration.Transform qualitative or quantitative data into fuzzy sets and describe the degree of affiliation of the elements to the set by setting the affiliation function, this step is the core of fuzzy set theory.Assign a value to the degree of membership of each case on each condition variable, usually between 0 and 1 and indicating the degree of affiliation.Correspond the various states of each case to the fuzzy subset of each explanatory variable to form the condition matrix.

(3) Necessity test.One-way necessity analysis is performed on conditional variables to clarify whether the variable is independently necessary to lead to a particular outcome.If the test finds that it is not necessary, it means that the conditional variable cannot determine the outcome variable alone, and the joint effect of other conditional variables must be considered.

(4) Truth table generation.Setting the cropping threshold for determining whether a case satisfies a condition or outcome.

(5) Group analysis.Simplifying and interpreting the results of the operations to find the most concise and sufficiently necessary configuration of conditions that can cover most of the cases in order to reveal causal patterns.

(6) Robustness testing.Further adjust the model parameters or revisit the data, conduct statistical tests or other forms of validation of the preliminary analysis results, and provide in-depth interpretation of the analysis results in the context of practical background and theoretical knowledge.

(7) Interpretation of results.Organize the analysis process and findings into a report that discusses the causal pathways found and their significance in the research field.

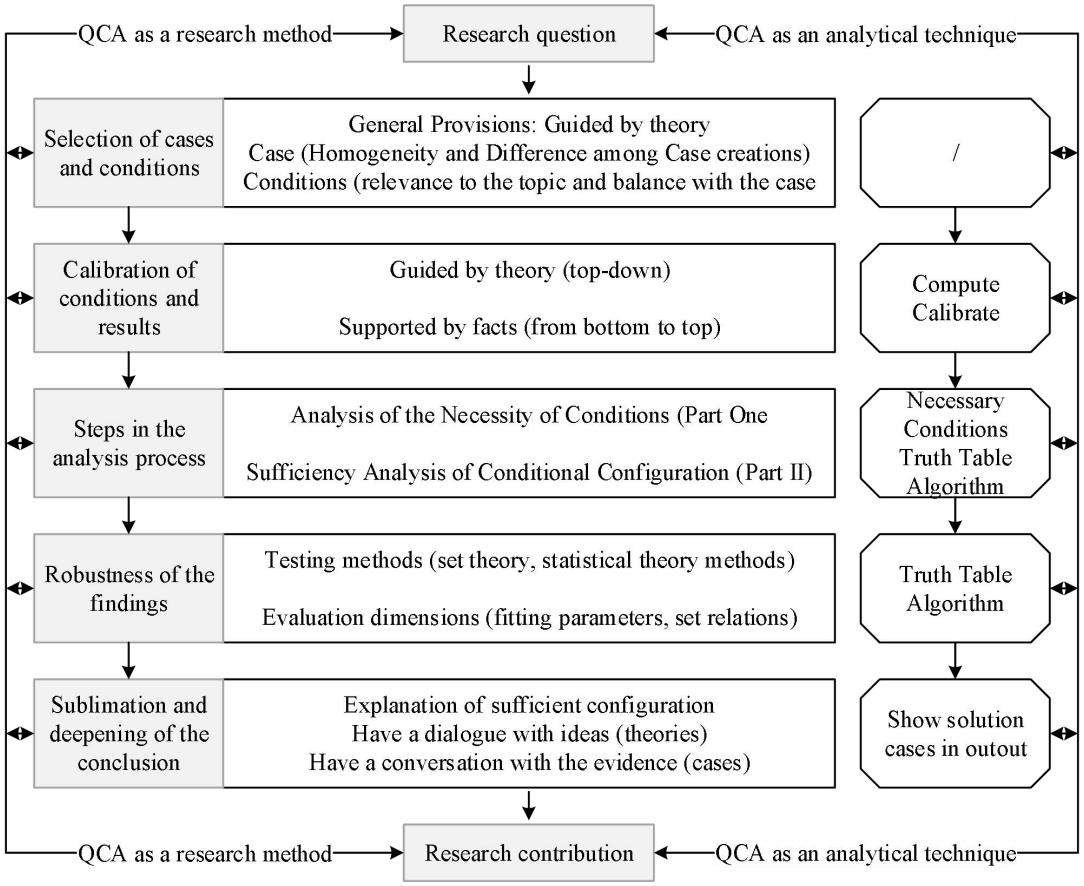

Figure 2. The specific operation process of fsQCA.

4. Comprehensive Analysis of Performance Management of English Teachers in Colleges and Universities

At present, in the performance management system of English teachers in colleges and universities, there are some phenomena such as focusing on rewards but not development, and focusing on scientific

research but not teaching, etc. All of these have, to a certain extent, dampened the enthusiasm of English teachers in colleges and universities and affected the healthy development of colleges and universities.We have to pay attention to the problem of performance evaluation of college English teachers and conduct a deeper examination of the performance evaluation system of college English teachers, look at the essence through the phenomenon, dig out the substantive problems hidden behind the phenomenon, and seek solutions from the root.

4.1. Performance Management Assessment for English Teachers

4.1.1. Weighting of Performance Management Indicators

This paper takes University Y as the research object, designs the questionnaire based on the English teacher performance management evaluation index system constructed in the previous article, distributes a total of 400 questionnaires, and recovers 387 valid questionnaires, with an effective recovery rate of 96.75%.Combined with the specific steps of entropy weighting method given in the previous section to calculate the weights of indicators, we can get the weight distribution of English teachers' performance management evaluation indicators as shown in Table 2.

Based on the data in the table, it can be seen that in the performance management evaluation index system of English teachers in colleges and universities based on the methodology of WSR system, the weights of physical, factual and human factors are relatively close to each other, and all of them have reached more than 30% of the weights.The weight values of physical, factual and humanistic factors are 0.3147, 0.3458 and 0.3395 respectively, and the gap between the three factors is between 1.86% and 9.88%.This indicates that in the performance management of English teachers in colleges and universities, whether it is physical factors, factual factors or human factors, all of them have a more intuitive impact on the performance management of English teachers, of which the factual factors have a relatively greater degree of influence.In addition, from the perspective of the weight of the secondary indicators, the weight of the English teachers' research incentives is the highest, with a weight value of 0.1347. From the perspective of the current era of development, the fusion of artificial intelligence technology and English education is deepening, and it is more reasonable to take into account the degree of English teachers' English on intelligent technology in the performance management of English teachers, which is reflected in the amount of the scientific research incentives for the English teachers.It is mainly reflected in the amount of research incentives for English teachers.And the intelligent technology used by English teachers in the teaching process and the publication of thesis will also have a greater impact, and its weight share reached 11.81%, ranking second.Moreover, from the reality, the teacher moral level of college teachers is also a key situation to be investigated in performance management, and the weight value of English teachers' character and personality is in the third place (0.1157), which also confirms this statement to a certain extent.Therefore, for the performance management of English teachers in colleges and universities, only by fully optimizing the three dimensions of physical, factual and humanistic, can the performance management level of English teachers be further enhanced, and the teaching reform enthusiasm of English teachers can also be significantly enhanced to provide support for the realization of intelligent reform of English teaching in colleges and universities.

Table 2. Evaluation index weight of English teacher performance management.

Dimension	Content	Weight	Relative weight
Physical factor (0.3147)	Teaching workload	0.2874	0.0905
	Teaching quality level	0.3521	0.1108
	Teaching reform results	0.3605	**0.1135**
Reasoning factor (0.3458)	Teacher research award	0.3895	**0.1347**
	The teacher is published	0.3416	**0.1181**
	Teacher research project	0.2689	0.0930
Human factor (0.3395)	Teaching education	0.3312	**0.1124**
	Professional ethics	0.3279	0.1113
	Teacher personality	0.3409	**0.1157**

4.1.2. Comprehensive Assessment of Performance Management

On the basis of University Y in the previous section, this paper further selects 19 universities in different regions to carry out the performance management evaluation of English teachers.Based on the weights of the evaluation indexes obtained above, combined with the steps of comprehensive assessment by the grey correlation analysis model given in the previous section and the standardized data, the

comprehensive scores of the performance management evaluation of English teachers of 20 universities (X1~X20) can be calculated.

In addition, this paper also clusters the universities with different comprehensive scores using the K-mean cluster analysis method in the SPSS software, and sets three different types of grades, i.e., high-level, intermediate and low-level, with comprehensive scores ranging from [0.65,1], [0.4,0.65), [0.0,0.45), respectively.

Based on the above steps, the comprehensive scores of English teachers' performance management in 20 universities were obtained as shown in Figure 3.

(1) Analyzing from the perspective of composite score, the mean value of English teachers' performance management level of the selected 20 universities is 0.543, and the overall floating range is between [0.32,0.87], among which, the English teachers' performance management level of X1 universities is the highest, and its composite score reaches 0.867, and the English teachers' performance management level of X20 universities is the lowest, which is only 0.327.OverallThe performance management level of English teachers in the selected 20 universities in different regions varies, and the overall performance management level of English teachers is not high.Only three colleges and universities have English teachers' performance management level above 0.8, accounting for 15%.The performance management level of English teachers in seven colleges and universities is between [0.5,0.7], accounting for 35%.There are 10 colleges and universities with English teachers' performance management level below 0.5, accounting for 50%.And the average value of English teachers' performance management level in 20 colleges and universities is within the interval of [0.5,0.7), so it is crucial to further improve the performance management level of English teachers in this part of colleges and universities.

(2) Analyzed from the perspective of level division, there are only five colleges and universities whose English teachers' performance management level is at the advanced level, accounting for 25%.The performance management level of English teachers in 8 colleges and universities is at the intermediate level, accounting for 40%.The performance management level of English teachers in 7 colleges and universities is at the low level, accounting for 35% respectively.It can be seen that some colleges and universities do not pay enough attention to the performance management of English teachers, and improving the overall level of performance management of English teachers in colleges and universities is a difficult problem that needs to be solved.

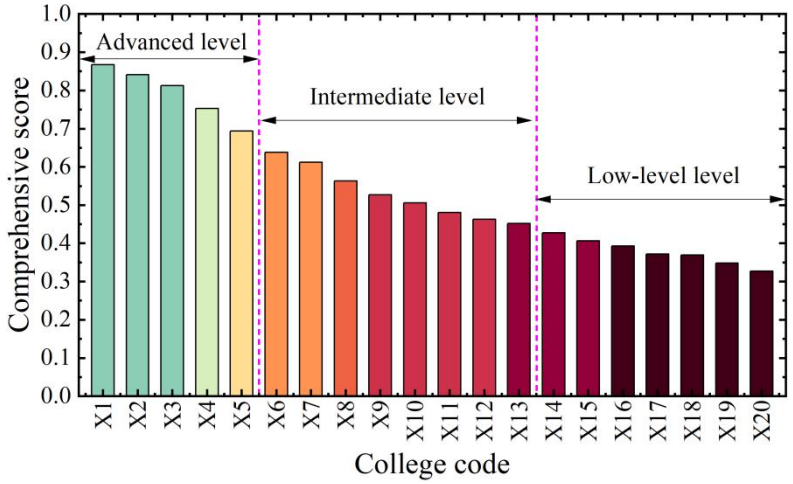

Figure 3. Comprehensive Scoring of English Teacher Performance Management.

4.2. Group Analysis of Teacher Performance Management

4.2.1. Necessity of Individual Conditions

In order to further illustrate how to effectively improve the performance management level of college English teachers and to clarify the role mechanism driving the performance management of college English teachers, this paper chooses fsQCA for analysis.The performance management level of college English teachers is taken as the dependent variable, and its value is derived from the previous gray correlation analysis.Then nine indicators including physical, matter and human factors are chosen as independent variables, still following the questionnaire data given in the previous section.

Variable calibration is the process of assigning pooled affiliation scores to the variables that need

strategies, in which three anchor points need to be set, namely, the completely unaffiliated anchor point, the crossover point, and the complete affiliation point as the calibration point of the data.In this paper, with reference to previous studies, the three anchor points are set as 75% quartile, 50% quartile and 25% quartile of the case data.Then the results of variable calibration anchor points are shown in Table 3.As can be seen from the table, the fully affiliated (75%) score for the performance management level of English teachers in higher education is 0.672, while the fully unaffiliated (25%) score is 0.104, and the intersection between the two (50%) is 0.318. Based on this, the relevant factors that have a more serious impact on the performance management level of English teachers in higher education can be clearly distinguished.

Table 3. Variable calibration anchor points.

Variable name		Calibration of fuzzy sets		
Dimension	Content	Complete subordination (75%)	Intersection point (50%)	Completely not affiliated (25%)
English teacher performance management level		0.672	0.318	0.104
Physical factor	Teaching workload	158.714	58.645	9.276
	Teaching quality level	0.835	0.461	0.115
	Teaching reform results	0.728	0.376	0.128
Reasoning factor	Teacher research award	38276.509	6157.312	634.626
	The teacher is published	7.763	3.041	1.174
	Teacher research project	12.556	6.938	1.585
Human factor	Teaching education	0.492	0.206	0.057
	Professional ethics	0.649	0.247	0.068
	Teacher personality	0.851	0.429	0.149

After completing the calibration of the variables, the necessity of individual conditions was further explored.When an outcome occurs, if a factor is always present, this factor is said to be a condition of necessity for the outcome.Referring to the practice of existing related studies, the necessity of each single factor in facilitating or constraining the level of performance management of English teachers in colleges and universities will be tested first.The consistency level is a measure of the necessity condition, which can show the extent to which cases with the same condition grouping belong to the same outcome, and this paper sets the consistency threshold of the necessity condition at 0.95. The fsQCA software is used to analyze the necessity conditions of high performance management level and non-high performance management level respectively, and the specific results of the analysis are shown in Table 4, in which "~" indicates non-.

The results show that for the high and non-high performance management level of English teachers in higher education, the consistency level of single condition variables is not higher than 0.95, so none of them constitutes a necessary condition.This indicates that a single element does not constitute a bottleneck for the performance management level of English teachers in colleges and universities.According to the educational ecological perspective, the influencing factors of teachers' performance management level are systematic and complex, and the synergistic influences of multiple factors such as physical, factual and human factors under the WSR framework need to be further analyzed.

Table 4. Necessity test for individual antecedent conditions.

Condition name	High performance management level		Non-high performance management level	
	Consistency	Coverage	Consistency	Coverage
Teaching workload	0.628	0.727	0.798	0.610
~ Teaching workload	0.671	0.661	0.659	0.753

Teaching quality level	0.677	0.714	0.703	0.658
~ Teaching quality level	0.646	0.777	0.601	0.734
Teaching reform results	0.775	0.642	0.712	0.610
~ Teaching reform results	0.690	0.643	0.662	0.773
Teacher research award	0.747	0.610	0.750	0.707
~ Teacher research award	0.677	0.749	0.779	0.772
The teacher is published	0.635	0.740	0.796	0.607
~ The teacher is published	0.719	0.615	0.797	0.642
Teacher research project	0.660	0.762	0.675	0.769
~ Teacher research project	0.614	0.627	0.621	0.702
Teaching education	0.609	0.775	0.698	0.773
~ Teaching education	0.629	0.769	0.734	0.744
Professional ethics	0.671	0.620	0.691	0.619
~ Professional ethics	0.690	0.759	0.621	0.682
Teacher personality	0.749	0.742	0.798	0.796
~ Teacher personality	0.785	0.664	0.657	0.648

4.2.2. Analysis of the Adequacy of the Configuration

This paper adopts fsQCA to analyze the adequacy of the antecedent condition groupings that lead to the high performance management level of English teachers in colleges and universities and the non-high performance management level of English teachers in colleges and universities, in order to deeply analyze the driving and constraining mechanisms of the high performance management level of English teachers in colleges and universities.Referring to the research results of existing related literature, this paper sets the case frequency threshold and original consistency threshold to 1 and 0.85, respectively; in addition, PRI is defined as "the proportion reduction of inconsistency", and by setting the value of PRI in the process of QCA analysis, we can avoid the inconsistency of a certain grouping in the result and the negation of the result.In the QCA analysis process, by setting the PRI value, we can avoid the inconsistency of a certain grouping in the result and the negation of the result, and the inconsistency may exist if the PRI value is lower than 0.55, so in this paper, we manually adjusted the data with the PRI value of less than 0.55 to zero.In the table, ● represents the appearance of conditions and ⊕ represents the absence of conditions, in which the big circle represents the core conditions, the small circle represents the marginal conditions, and the blank indicates that the conditions can appear or be absent.

As can be seen from the table, the paths of high and non-high performance management level of college English teachers are long out of the diversified results, and there are two and three paths that produce high and non-high performance management level of college English teachers, respectively, and the coverage of the overall solution reaches more than 72%, which indicates that the grouped paths are effective in explaining most of the case scenarios.

There are 2 environmental grouping paths that generate high performance management level of college English teachers, which are H1 (thing-thing-person) comprehensive-driven and H2 (thing-thing) teaching-research-driven.

(1) H1 (thing-thing-person) comprehensive driven type.H1 indicates that high teaching workload, high level of teaching quality, high teacher research rewards, high professional ethical standards and high teacher personality are the core conditions, and high teaching reform results, high publication of theses and high level of teaching and educating people are the peripheral conditions that can promote the performance level of English teachers in colleges and universities to become higher.This grouping indicates that the elements of physical, factual and human factors in the process of college performance management are intertwined and mutually reinforcing, and that the aggregation effect they form together has a significant positive impact on the high performance management of English teachers.The multi-dimensional and dynamic balance of the good environment can greatly promote the enthusiasm of English teachers, resulting in high performance management.

(2) H2 (thing-thing) teaching-research driven.H2 states that high teaching quality and high research projects are the core conditions, and complementary high teacher research awards and high publications are the marginal conditions that can enhance English teachers' high performance management level.Different from the group H1, regardless of the results of teaching reforms, the complementary high level of teachers' research incentives and high level of publications can effectively enhance English teachers' high performance management level under the synergistic pull of professional ethics and teachers' personality.English teachers rely on artificial intelligence technology to give English teaching more intelligent level, promote the improvement of English teaching quality, and then integrate more resources and capabilities, effectively empowering the establishment and development of English

teachers' digital capabilities, the higher the popularity of which injects kinetic energy into intelligent scientific research in English education and promotes the generation of English teachers' teaching reform behaviors, which in turn enhances the level of English teachers' English performance management in colleges and universities.

Table 5. Sufficiency analysis of configuration.

Antecedent condition	High performance management		Non-high-performance management		
	H1	H2	NH1	NH2	NH3
W1	●	•		⊕	
W2	●	●	⊕	⊕	•
W3	⊕	⊕	⊕	●	•
S1	●	⊕	⊕	⊕	⊕
S2	⊕	⊕	⊕	⊕	●
S3	•	●	⊕	●	⊕
R1	⊕	⊕	⊕	•	●
R2	●	•		•	
R3	●	•			•
Consistency	0.815	0.937	0.811	0.884	0.923
Original coverage	0.604	0.285	0.543	0.351	0.269
Unique coverage	0.178	0.026	0.319	0.031	0.022
Consistency of the overall solution	0.812		0.836		
The coverage of the overall solution	0.724		0.757		

4.2.3. Robustness Test of the Results

It has been pointed out that a specific method based on set theory is preferred for the robustness test of QCA grouping results, which specifically includes adjusting the calibration anchor point, adjusting the consistency threshold, and adjusting the frequency number of cases as the robustness test method for the 3 qualitative comparative analysis methods.The reason for adopting the robustness test method of adjusting the consistency threshold in this study is mainly based on the following 2 considerations:

(1) Since the data for the outcome variable of the performance management level of college English teachers in this study are based on the outcome data measured by the empirical evaluation in the previous section, the reference standard for adjusting the calibration anchor point accordingly is lacking in practice or established research, so it is difficult to implement the robustness test through the method of adjusting the anchor point.

(2) In terms of the number of cases, the 20 colleges and universities do not belong to a large sample of cases, and if the frequency of cases is adjusted then there is a risk that the grouping will not exist.

Based on the above considerations, the study concluded that adjusting the consistency threshold may be more suitable for the robustness test in this study.Specifically, after first adjusting the PRI consistency threshold from 0.85 to 0.90 for the antecedent group state of high performance management level of English teachers in colleges and universities, the results of the newly generated conditional group state did not change significantly compared with the results of the aforementioned conditional group state.In order to make the results more reliable, the study further increased the consistency threshold to 0.95 after tuning to produce a new conditional grouping pattern, as shown in Table 6.After the consistency threshold was adjusted to 0.95, the consistency and coverage of the solution changed, with the consistency value increasing from 0.812 to 0.895, and the coverage value decreasing from 0.724 to 0.706. Comparing Table 6 and Table 5, it can be seen that the paths of the new conditional histograms did not undergo any particularly large changes, which suggests that the results of the study have a certain degree of robustness.

Table 6. Robustness test results.

Antecedent condition	High performance management		Non-high-performance management		
	H1	H2	NH1	NH2	NH3

W1	●	⊕	⊕	⊕	
W2	●	●	⊕	⊕	•
W3	⊕	•	⊕	●	•
S1	⊕	⊕	⊕	⊕	⊕
S2	●	⊕	⊕	⊕	●
S3	•	●	⊕	●	⊕
R1	⊕	•	⊕	•	●
R2	●	⊕		•	•
R3	●	•	⊕		
Consistency	0.892	0.975	0.842	0.915	0.968
Original coverage	0.657	0.691	0.576	0.376	0.284
Unique coverage	0.152	0.137	0.337	0.064	0.035
Consistency of the overall solution	0.895		0.927		
The coverage of the overall solution	0.706		0.739		

5. Conclusion

Exploring the development path of performance management for college English teachers is an important issue to further enhance the teaching motivation of college English teachers and promote the reform of college English teaching.Based on the WSR method, this study combines the artificial intelligence technology with the matter-of-fact framework, constructs a performance management model for English teachers in colleges and universities, and designs an evaluation index system for English teachers' performance management.Based on the results of empirical analysis, it is shown that the mean value of English teachers' performance management level is 0.543 points, and the overall fluctuation is large.And there are two significant paths for high performance management level of English teachers in colleges and universities, and further increasing the input of intelligent technology and other matter factors can significantly improve the performance management level of English teachers in colleges and universities.

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