

PAPER

Decision Analysis and Practical Pathways for Innovative Teaching Methods in Information Technology Education

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ABSTRACT

With the rapid advancement of information technology, its integration into modern education has become essential, with a focus on enhancing teaching outcomes and the student learning experiences through innovative teaching methods. However, existing studies predominantly suffer from a lack of systematic evaluation indicators and scientific decision models. The selection of evaluation indicators is often subjective, incomplete, and primarily qualitative, lacking quantitative data support. A systematic decision analysis method was proposed in this study to address these issues. This study comprises three components: the construction of an evaluation indicator system for innovative teaching methods in information technology education, a scale analysis based on gray relational degree, and the computational steps for the decision model concerning innovative teaching methods. This study provides scientific bases and practical pathways for the selection of innovative teaching methods in information technology education, aiming to enhance teaching effectiveness and educational quality.

KEYWORDS

information technology education, innovative teaching methods, gray relational degree, evaluation indicator system, decision model

1 INTRODUCTION

As information technology rapidly advances, profound changes have been witnessed within the educational domain. Information technology education has gradually emerged as a crucial component of modern educational systems and primarily focuses on enhancing teaching effectiveness and the learning experiences of students through innovative teaching methods [1–4]. However, in the face of emerging technologies and methods, educators require scientific decision-making tools to evaluate and select the optimal teaching methods, aiming to improve teaching quality and optimize the allocation of educational resources [5, 6]. Thus, it is of significant practical importance and urgency to study the scientific decision-making process for innovative teaching methods in information technology education.

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This study explores decision analysis and practical pathways for innovative teaching methods in information technology education by establishing a scientific evaluation indicator system and a decision model and providing effective tools and methodologies for educational decision-makers [7–9]. Through scientific decision analysis, not only are the accuracy and rationality of selecting teaching methods enhanced, but the effective utilization of educational resources and maximization of student learning outcomes are also promoted [10–13]. The outcomes of this study offer theoretical support and practical guidance for educational practice, fostering the in-depth development of information technology education and the widespread application of innovative teaching methods.

Although numerous studies have explored innovative teaching methods in information technology education, most lack a systematic evaluation indicator system and a scientific decision model [14–16]. The selection of evaluation indicators often suffers from strong subjectivity and incompleteness, leading to low credibility and practicality of the assessment results [17–19]. Additionally, existing decision methods are predominantly qualitative, lacking quantitative data support, which makes it difficult to accurately measure the merits of different teaching methods. These deficiencies significantly hinder the promotion and application of innovative teaching methods in actual educational settings.

In response to these issues, a systematic decision analysis method was proposed in this study, which comprises three main study components. Initially, an evaluation indicator system for innovative teaching methods in information technology education was constructed, providing comprehensive, scientific support for subsequent decision analysis. Subsequently, a scale analysis based on gray relational degree was conducted to quantify the proximity of each teaching method to the ideal state, enhancing the objectivity and accuracy of the assessment. Finally, the computational steps of the decision model for innovative teaching methods were detailed, offering scientific decision-making tools. This study aims to provide a scientific basis and practical pathways for selecting innovative teaching methods in information technology education, thereby enhancing teaching effectiveness and educational quality. Therefore, this study has significant theoretical and practical value.

2 IMPLEMENTATION PATHWAYS AND EVALUATION INDICATOR SYSTEM FOR INNOVATIVE TEACHING METHODS IN INFORMATION TECHNOLOGY EDUCATION

Figure 1 illustrates an example of a decision model for innovative teaching methods in information technology education. To effectively evaluate innovative teaching methods in information technology education, a comprehensive evaluation indicator system was constructed, as shown in Figure 2. This system should encompass various factors to ensure the comprehensiveness and scientific nature of the evaluation. By scientifically assessing teaching effectiveness, the evaluation indicator system can comprehensively measure multiple aspects such as students' learning outcomes, interest, and satisfaction, thereby providing a quantitative basis for teaching improvements. Additionally, ensuring teaching quality remains central to education. By identifying strengths and weaknesses during the teaching process, continuous enhancement of teaching quality can be ensured. The evaluation indicator system also supports personalized learning. By analyzing students' learning data, insights into their progress and outcomes can be gained, thereby providing

data support for developing personalized teaching plans. The framework of the evaluation indicator system is as follows:

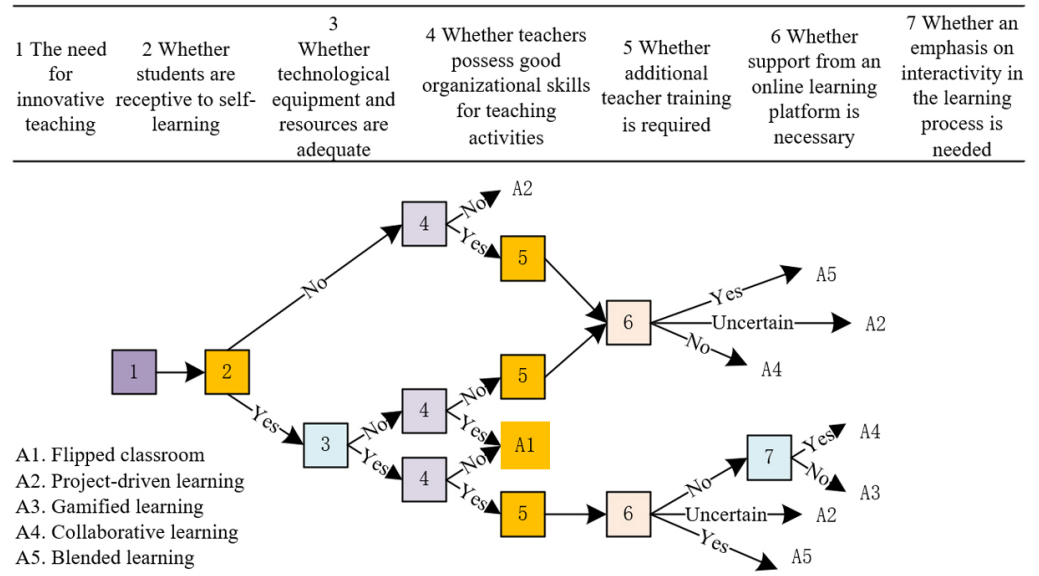


Fig. 1. Example of a decision model for innovative teaching methods in information technology education

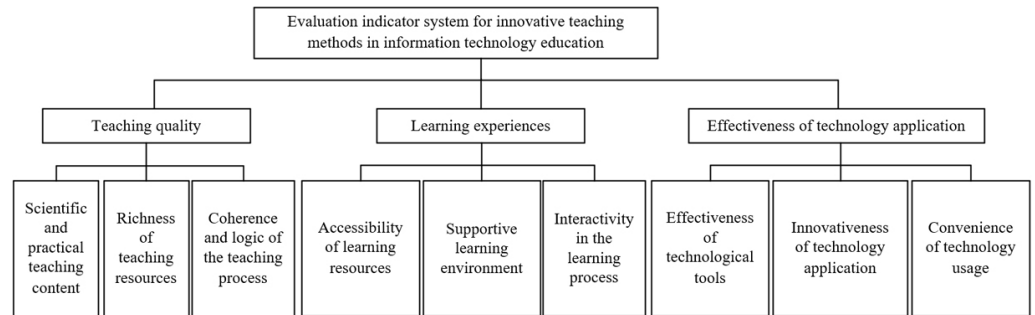


Fig. 2. Evaluation indicator system for innovative teaching methods in information technology education

- a) Teaching quality
 - Scientific and practical teaching content: whether the teaching content is scientific, cutting-edge, and has practical application value.
 - Richness of teaching resources: whether teaching resources are abundant, including textbooks, courseware, videos, and experimental equipment.
 - Coherence and logic of the teaching process: whether the teaching process is coherent and logical.
- b) Learning experiences
 - Accessibility of learning resources: whether students can conveniently access the required learning resources.
 - Supportive learning environment: whether the learning environment supports student learning, including technical support and the stability and usability of learning platforms.
 - Interactivity in the learning process: The nature of students' interactions during the learning process, including interactions with teachers and peers.

- c) Effectiveness of technology application
 - Effectiveness of technological tools: whether the technological tools used effectively support the achievement of teaching objectives.
 - Innovativeness of technology application: whether the technological tools and methods used are innovative.
 - Convenience of technology usage: The convenience for students and teachers when using technological tools.

3 SCALE ANALYSIS BASED ON GRAY RELATIONAL DEGREE

The application of innovative teaching methods in this field involves multiple factors, such as the learning outcomes of students, the teaching satisfaction of educators, the efficiency of resource utilization, and the effectiveness of technological tools. Additionally, data in the educational sector often exhibits uncertainty, especially during the initial stages of introducing innovative teaching methods, where substantial historical data may be lacking. The grey relational degree technique for order preference by similarity to the ideal solution (TOPSIS) decision model was selected for decision analysis and the planning of practical pathways. This model is capable of considering these multidimensional factors comprehensively. By weighting the importance of each factor, the decision-making process is ensured to be comprehensive and scientific. Excelling in handling uncertainty and limited data samples, the model calculates the relational degrees between different teaching methods and an ideal solution, providing reliable decision support in situations of incomplete data.

The steps of the gray relational analysis methodology are as follows:

Step 1: Data collection and construction of a gray relational matrix based on the evaluation indicator system.

Initially, relevant data were collected and organized based on the evaluation indicator system for innovative teaching methods. Evaluation indicators may include the learning outcomes of students, the efficiency of resource utilization in teaching, the satisfaction of teachers, and the effectiveness of technological tools. The collected data were organized to construct a gray relational matrix, preparing for subsequent analysis. The expression for the gray relational matrix is as follows:

$$(A'_1, A'_2, \dots, A'_v) = \begin{bmatrix} a'_1(1) & a'_2(1) & \dots & a'_v(1) \\ a'_1(2) & a'_2(2) & \dots & a'_v(2) \\ \vdots & \vdots & \vdots & \vdots \\ a'_1(l) & a'_2(l) & \dots & a'_v(l) \end{bmatrix} \quad (1)$$

Step 2: Identification of reference and comparison sequences.

In gray relational analysis, a reference sequence, $A'_0 = (a'_0(1), a'_0(2), a'_0(3) \dots a'_0(l))$, and several comparison sequences, $A'_u = (a'_u(1), a'_u(2), a'_u(3) \dots a'_u(l))$, were determined. The reference sequence typically represents the ideal implementation effect of innovative teaching methods, which is the target state desired by decision-makers. Comparison sequences represent the actual performance of different teaching methods across various evaluation indicators.

Step 3: Normalization of original data to obtain standardized data sequences.

As the data units and dimensions of various evaluation indicators might differ, the original data require normalization to allow for comparisons under the same dimension. Common normalization methods include range standardization

and *Z-score* standardization. Standardized data sequences were obtained after standardization.

$$(A_0, A_1, \dots, A_v) = \begin{bmatrix} a_0(1) & a_1(1) & \dots & a_v(1) \\ a_0(2) & a_1(2) & \dots & a_v(2) \\ \vdots & \vdots & \vdots & \vdots \\ a_0(l) & a_1(l) & \dots & a_v(l) \end{bmatrix} \quad (2)$$

Step 4: Calculation of gray relational coefficients.

After the normalization process, the gray relational coefficients between each comparison sequence and the reference sequence were calculated. The formula for calculating the gray relational coefficient is as follows:

$$\gamma_u(j) = \frac{\underset{u}{MIN} \underset{j}{MIN} |a_0(j) - a_u(j)| + \vartheta \underset{u}{MAX} \underset{j}{MAX} |a_0(j) - a_u(j)|}{|a_0(j) - a_u(j)| + \vartheta \underset{u}{MAX} \underset{j}{MAX} |a_0(j) - a_u(j)|} \quad (3)$$

Step 5: Calculation of gray relational degree based on gray relational coefficients.

Once the gray relational coefficients were computed, the gray relational degree between each comparison sequence and the reference sequence was calculated. The gray relational degree, representing the average of all gray relational coefficients, reflects the similarity between the comparison sequences and the reference sequence comprehensively.

$$e_u = \frac{1}{l} \sum_{j=1}^l \gamma(j) \quad (4)$$

With the calculated gray relational degrees, the effectiveness of each innovative teaching method was assessed. A higher gray relational degree indicates a closer approximation of the teaching method's effectiveness to the ideal state. Based on the magnitude of the gray relational degrees, different teaching methods were ranked, and the most optimal innovative teaching method was selected for implementation.

This study aims to guide educators in selecting the most optimal innovative teaching method through scientific decision analysis. Grey relational analysis, as a multi-factor decision-making method, finds significant applicability in this scenario, with the gray relational degree serving as a crucial measure.

In information technology education, the evaluation indicators for innovative teaching methods might include student learning outcomes, the efficiency of resource utilization in teaching, teacher satisfaction, and the effectiveness of technological tools. These indicators are characterized by their multidimensionality and complexity. In decision analysis, alternative schemes are considered comparison sequences, while reference sequences are the positive and negative ideal solutions. The positive ideal solution represents the optimal state for each evaluation indicator, i.e., the ideal effect of implementing innovative teaching methods. Conversely, the negative ideal solution represents the worst state, i.e., the least desirable outcome of a teaching method. By calculating the gray relational degrees between each alternative and both the positive and negative ideal solutions, the merits of each scheme can be evaluated. Gray relational degree reflects the geometric similarity of the data curves of different schemes, whereas traditional Euclidean distance measures the positional distance between these curves. Combining gray relational degree with

Euclidean distance forms a new measure of closeness that considers both position and geometric shape, making decision analysis more comprehensive and objective. The integration with Euclidean distance to calculate positional similarity effectively mitigates the limitations that might arise from using a single method. For example, a teaching method might perform excellently on certain indicators but poorly on others. The combination of gray relational degree and Euclidean distance allows for a holistic assessment of its overall effectiveness, avoiding one-sided judgments.

The dynamic nature of information technology education environments and student needs means that gray relational analysis must be adaptable to these changes. The calculation of gray relational degree can be dynamically adjusted based on the latest data, ensuring the timeliness and effectiveness of decision analysis. This is crucial for the continuous improvement and optimization of the selection of teaching methods. For instance, in evaluating the effectiveness of various innovative teaching methods A , B , C , and D , the gray relational degrees of each teaching method relative to positive and negative ideal solutions are calculated by establishing these solutions. If teaching method A has the highest gray relational degree to the positive ideal solution and the lowest to the negative ideal solution, then it would be considered the optimal choice.

4 COMPUTATIONAL STEPS OF THE DECISION MODEL FOR INNOVATIVE TEACHING METHODS IN INFORMATION TECHNOLOGY EDUCATION

The computational steps of the decision model are as follows:

Step 1: Establishment of the initial decision matrix.

In information technology education, the evaluation of innovative teaching methods requires consideration of multiple aspects. Identifying these evaluation indicators constitutes the first and most crucial step of the decision process, as the choice of indicators directly influences the subsequent assessment results. Specifically, several alternative innovative teaching method schemes were defined, denoted as $L = \{L_1, L_2, L_3, \dots, L_l\}$, and multiple evaluation indicators were identified, denoted as $V = \{V_1, V_2, V_3, \dots, V_v\}$. These indicators typically involve aspects such as the effectiveness of the teaching methods, student engagement, the applicability of technological tools, teacher satisfaction, and the utilization rate of teaching resources. The evaluation values of each teaching method across these indicators form the initial decision matrix $X = [x_{uk}]_{l \times v}$, where x_{uk} represents the score of the u -th teaching method on the k -th indicator.

$$X = \begin{bmatrix} x_{11} & x_{12} & x_{13} & \cdots & x_{1v} \\ x_{21} & x_{22} & x_{23} & \cdots & x_{2v} \\ x_{31} & x_{32} & x_{33} & \cdots & x_{3v} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ x_{l1} & x_{l2} & x_{l3} & \cdots & x_{lv} \end{bmatrix} \quad (5)$$

Step 2: Data standardization.

The decision matrix serves as a tool to quantify and summarize the performance of each candidate teaching method across various evaluation indicators. In information technology education, constructing the decision matrix requires the collection of a substantial amount of actual data. This step is not only a comprehensive

evaluation of existing teaching methods but also a process of systematic reflection and improvement on issues in teaching practice. By constructing the decision matrix, decision-makers can visually observe the specific performances of various teaching methods across different indicators, providing data support for subsequent comprehensive evaluations. Specifically, the initial matrix $X = [x_{uk}]_{l \times v}$ was transformed into the standardized decision matrix $E = [e_{uk}]_{l \times v}$, thereby eliminating the differences in dimensions among the indicators and ensuring comparability.

$$e_{uk} = \frac{x_{uk} - \text{MIN}_k x_{uk}}{\text{MAX}_k x_{uk} - \text{MIN}_k x_{uk}} \tag{6}$$

$$e_{uk} = \frac{\text{MAX}_k x_{uk} - x_{uk}}{\text{MAX}_k x_{uk} - \text{MIN}_k x_{uk}} \tag{7}$$

Step 3: Construction of the weighted normalized decision matrix.

In information technology education, indicators such as teaching effectiveness, student engagement, and technology applicability might use different measurement units. Due to the varying scales and dimensions of the evaluation indicators, the decision matrix requires normalization to eliminate these differences, ensuring that each indicator is comparable. In this study, the importance of each evaluation indicator was determined using combination weights (μ^*) calculated through game theory. These weights reflect the relative importance of each indicator in the decision-making process. The combination weights were multiplied by the normalized matrix $E = [e_{uk}]_{l \times v}$ to obtain the weighted normalized matrix $B = [b_{uk}]_{l \times v}$, where $b_{uk} = \mu_k^* \cdot e_{uk}$.

$$B = \mu^* \cdot e = \begin{bmatrix} \mu_1^* \cdot e_{11} & \mu_2^* \cdot e_{12} & \mu_3^* \cdot e_{13} & \cdots & \mu_4^* \cdot e_{1v} \\ \mu_1^* \cdot e_{21} & \mu_2^* \cdot e_{22} & \mu_3^* \cdot e_{23} & \cdots & \mu_4^* \cdot e_{2v} \\ \mu_1^* \cdot e_{31} & \mu_2^* \cdot e_{32} & \mu_3^* \cdot e_{33} & \cdots & \mu_4^* \cdot e_{3v} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \mu_1^* \cdot e_{l1} & \mu_2^* \cdot e_{l2} & \mu_3^* \cdot e_{l3} & \cdots & \mu_4^* \cdot e_{lv} \end{bmatrix} \tag{8}$$

Step 4: Identification of the positive and negative ideal solutions.

In information technology education, the ideal solution typically represents the optimal values for each evaluation indicator, such as the highest scores for teaching effectiveness or the most positive student feedback. Conversely, the negative ideal solution represents the worst values. The purpose of this step is to provide reference points for subsequent calculations of gray relational degree and Euclidean distance, quantifying the relative merits of each teaching method by comparison with these ideal solutions. Identifying the positive and negative ideal solutions not only clarifies the assessment criteria but also offers decision-makers a clear goal orientation, aiding in a more targeted selection of innovative teaching methods. Specifically, within the weighted normalized matrix, the positive ideal solution C^+ and the negative ideal solution C^- represent the best and worst combinations of indicators, respectively.

$$C^+ = (\text{MAX}_{1 \leq u \leq l} b_{uk} \mid k \in k^+, \text{MIN}_{1 \leq u \leq l} b_{uk} \mid k \in k^-) = (c_1^+, c_2^+, \dots, c_v^+) \tag{9}$$

$$C^- = (\text{MIN}_{1 \leq u \leq l} b_{uk} \mid k \in k^+, \text{MAX}_{1 \leq u \leq l} b_{uk} \mid k \in k^-) = (c_1^-, c_2^-, \dots, c_v^-) \tag{10}$$

Step 5: Calculation of the gray relational degree.

By calculating the gray relational coefficients between each teaching method and both the positive and negative ideal solutions, decision-makers are enabled to quantify the proximity of each teaching method to the ideal state. The gray relational degree reflects the similarity of the performance of each teaching method across different evaluation indicators to the best possible state, providing clear data support for decision-making. Especially in information technology education, the innovation of teaching methods requires precise evaluation, and the gray relational degree offers this precision.

$$C^+ = [c_1^+, c_2^+, c_3^+, \dots, c_k^+, \dots, c_v^+] C^- = [c_1^-, c_2^-, c_3^-, \dots, c_k^-, \dots, c_v^-] C_u = [c_{1u}^+, c_{2u}^+, c_{3u}^+, \dots, c_{ku}^+, \dots, c_{vu}^+]$$

For the u -th alternative scheme, the gray relational coefficients with the positive and negative ideal solutions for the k -th indicator, denoted as γ_{uk}^+ and γ_{uk}^- , were calculated assuming a resolution coefficient represented by ϑ .

$$\gamma_{uk}^+ = \frac{\min_{u \in I} \min_{k \in V} |c_k^+ - c_{uk}^+| + \vartheta \max_{u \in I} \max_{k \in V} |c_k^+ - c_{uk}^+|}{|c_k^+ - c_{uk}^+| + \vartheta \max_{u \in I} \max_{k \in V} |c_k^+ - c_{uk}^+|} \quad (11)$$

$$\gamma_{uk}^- = \frac{\min_{u \in I} \min_{k \in V} |c_k^- - c_{uk}^-| + \vartheta \max_{u \in I} \max_{k \in V} |c_k^- - c_{uk}^-|}{|c_k^- - c_{uk}^-| + \vartheta \max_{u \in I} \max_{k \in V} |c_k^- - c_{uk}^-|} \quad (12)$$

The matrix of gray relational coefficients between the decision schemes and both the positive and negative ideal solutions is as follows:

$$\gamma^+ = \begin{bmatrix} \gamma_{11}^+ & \gamma_{12}^+ & \dots & \gamma_{1v}^+ \\ \gamma_{21}^+ & \gamma_{22}^+ & \dots & \gamma_{2v}^+ \\ \vdots & \vdots & \dots & \vdots \\ \gamma_{l1}^+ & \gamma_{l2}^+ & \dots & \gamma_{lv}^+ \end{bmatrix}, \gamma^- = \begin{bmatrix} \gamma_{11}^- & \gamma_{12}^- & \dots & \gamma_{1v}^- \\ \gamma_{21}^- & \gamma_{22}^- & \dots & \gamma_{2v}^- \\ \vdots & \vdots & \dots & \vdots \\ \gamma_{l1}^- & \gamma_{l2}^- & \dots & \gamma_{lv}^- \end{bmatrix} \quad (13)$$

Ultimately, the gray relational degrees of the u -th decision scheme with the positive and negative ideal solutions, denoted as d_u^+ and d_u^- , were obtained.

$$d_u^+ = \frac{1}{v} \sum_{k=1}^v \gamma_{uk}^+, d_u^- = \frac{1}{v} \sum_{k=1}^v \gamma_{uk}^- \quad (14)$$

Step 6: Calculation of Euclidean distance.

The calculation of Euclidean distance provides decision-makers with an intuitive method to measure the differences between each teaching method and the ideal solutions. In information technology education, indicators such as the effectiveness of teaching methods, student engagement, and the applicability of technological tools are multidimensional. By computing the Euclidean distance, decision-makers can clearly see the composite performance of each teaching method across these dimensions. This geometric distance measurement simplifies the complex evaluation process, aiding decision-makers in quickly identifying the teaching methods that are closest to the ideal solution. The Euclidean distances to the positive ideal solution, denoted as f_u^+ , and to the negative ideal solution, denoted as f_u^- , were calculated as follows:

$$f_u^+ = \sqrt{\sum_{k=1}^v (b_{uk} - c_k^+)^2}, f_u^- = \sqrt{\sum_{k=1}^v (b_{uk} - c_k^-)^2} \tag{15}$$

Step 7: Calculation of relative closeness.

The selection of innovative teaching methods requires consideration not only of their proximity to the optimal state but also of their overall performance across various indicators, as reflected by the Euclidean distance. Relative closeness provides decision-makers with a comprehensive evaluation metric, making the assessment results more holistic and scientific, thereby facilitating the selection of the most effective teaching method in practical applications. The calculation formula is as follows:

$$Z_u^* = \frac{T_u^*}{T_u^+ + T_u^-} \tag{16}$$

Step 8: Ranking and decision-making.

By ranking the various teaching methods, decision-makers can visually assess the merits and shortcomings of each method, thereby making an optimal selection. The teaching methods were ranked according to the size of their relative closeness, denoted as Z_u^* . The larger the Z_u^* , the closer the teaching method is to the positive ideal solution, and the better its effectiveness. Based on the ranking results, decision-makers can select the most optimal innovative teaching method for implementation. Figure 3 illustrates the system architecture of the decision-making platform for innovative teaching methods in information technology education.

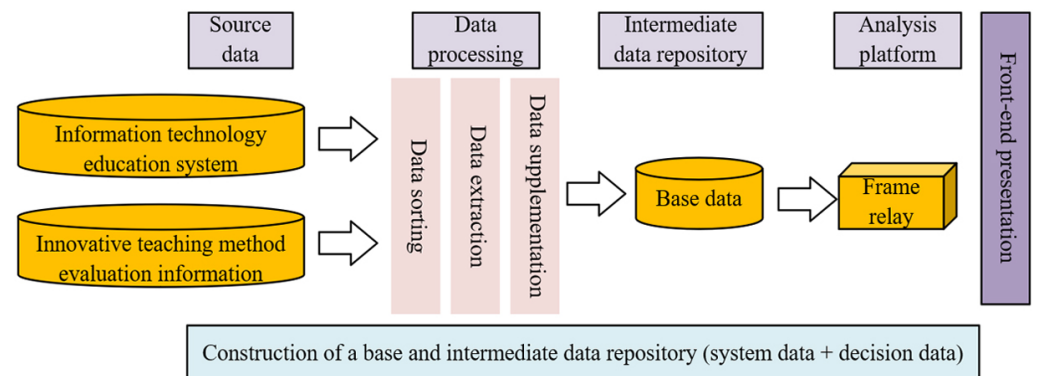


Fig. 3. System architecture diagram of the decision-making platform for innovative teaching methods in information technology education

5 EXPERIMENTAL RESULTS AND ANALYSIS

Table 1. Judgment matrix for the target layer

A	Teaching Quality	Learning Experiences	Technological Application Effectiveness
Teaching quality	1	1/2	1/3
Learning experiences	2	1	1/3
Technological application effectiveness	3	3	1

Table 1 displays the judgment matrix of relative importance among the three main indicators within the evaluation indicator system for innovative teaching methods in information technology education. In this matrix, the relative importance of teaching quality to learning experiences is 1:2, teaching quality to technological application effectiveness is 1:3, and learning experiences to technological application effectiveness is 1:3. These ratios reflect the importance of ranking different indicators within the evaluation system, aiding subsequent quantitative analysis and weight calculation.

In this study, technological application effectiveness is considered the most crucial indicator, followed by learning experiences, with teaching quality being the least critical. The primary reason is that in information technology education, the effectiveness and application of technological tools are considered key factors in achieving educational objectives and enhancing teaching quality. The importance of the learning experiences, which underscore the significance of accessing resources, environmental support, and interactivity in the learning process, is considered secondary.

Table 2. Weight solutions based on game theory

B-Level Indicators	C-Level Indicators	AHP	EWM	Combination Weights Based on Game Theory
Teaching quality	Scientific and practical teaching content	0.102	0.074	0.098
	Richness of teaching resources	0.054	0.114	0.061
	Coherence and logic of the teaching process	0.072	0.105	0.073
Learning experiences	Accessibility of learning resources	0.081	0.178	0.091
	Supportive learning environment	0.046	0.072	0.048
	Interactivity in the learning process	0.031	0.135	0.037
Technological application effectiveness	Effectiveness of technological tools	0.019	0.092	0.033
	Innovativeness of technology application	0.456	0.124	0.423
	Convenience of technology usage	0.139	0.106	0.136

Table 2 displays the weight calculation results of combination weights based on AHP, the entropy weight method (EWM), and game theory in the evaluation indicator system of innovative teaching methods in information technology education. According to the specific data, the weights for the scientific and practical teaching content are 0.102, 0.074, and 0.098, respectively, across the three methods; the weights for the richness of teaching resources are 0.054, 0.114, and 0.061, respectively; and the weights for the coherence and logic of the teaching process are 0.072, 0.105, and 0.073, respectively. In terms of learning experiences, the weights for accessibility of learning resources are 0.081, 0.178, and 0.091; the weights for

the supportive learning environment are 0.046, 0.072, and 0.048; and the weights for interactivity in the learning process are 0.031, 0.135, and 0.037. Regarding technological application effectiveness, the weights for the effectiveness of technological tools are 0.019, 0.092, and 0.033; the weights for the innovativeness of technology application are 0.456, 0.124, and 0.423; and the weights for convenience of technology usage are 0.139, 0.106, and 0.136. The comparison reveals that the combination weights based on game theory are more evenly distributed across the indicators.

By comparing the weight allocation results of the three methods, it can be observed that the combination weights based on game theory reflect the importance of each evaluation indicator more comprehensively and balanced. In terms of technological application effectiveness, the innovativeness of technology application remains the most crucial indicator, with a combination weight of 0.423, underscoring the key role of innovative technology in achieving educational objectives. Similarly, the importance of scientific and practical teaching content (0.098) and the accessibility of learning resources (0.091) highlight their significance in innovative teaching methods. These data suggest that the practical applicability of content and the ease of accessing resources are vital in teaching design. Other indicators, such as the convenience of technology usage (0.136) and the supportive learning environment (0.048), also hold importance. Although their weights are relatively lower, they still need to be considered in practical applications. Overall, the combination weights based on game theory provide a more scientifically sound basis for decision-making in information technology education, aiding in enhancing teaching quality and student learning experiences.

Table 3. Relative closeness to the ideal solution for each scheme

Sample ID	T^+	T^-	Relative Closeness	Ranking
1	0.6598	0.5213	0.5542	4
2	0.6234	0.6548	0.4789	5
3	0.7651	0.5123	0.5985	2
4	0.9452	0.4895	0.6512	1
5	0.5326	0.6657	0.4326	6
6	0.5214	1.0000	0.3256	8
7	0.7359	0.5412	0.5784	3
8	0.4562	1.0235	0.2986	9
9	0.5189	0.7548	0.4012	7

Table 3 demonstrates the relative closeness to the ideal solution for each scheme. The data include three key indicators: T^+ (distance to the positive ideal solution), T^- (distance to the negative ideal solution), and relative closeness (the comprehensive evaluation value of the scheme). According to the data, Sample ID 4 has a T^+ of 0.9452, a T^- of 0.4895, and a relative closeness of 0.6512, ranking first, indicating it is closest to the ideal solution. Following are Sample ID 3, ranked second with a T^+ of 0.7651, a T^- of 0.5123, and a relative closeness of 0.5985, and Sample ID 7, ranked third with a T^+ of 0.7359, a T^- of 0.5412, and a relative closeness of 0.5784. The lowest ranked is Sample ID 8, with a T^+ of 0.4562, a T^- of 1.0235, and a relative closeness of only 0.2986, indicating the greatest distance from the ideal solution.

According to the data in Table 4, it is evident that the scheme of Sample ID 4 performs best across the evaluation indicators, with a relative closeness of 0.6512, suggesting that this scheme is the closest to the positive ideal solution with the highest priority. Following closely are Sample IDs 3 and 7, with relative closeness values of 0.5985 and 0.5784, respectively, also showing high priority. In contrast, Sample IDs 8 and 6, with relative closeness values of 0.2986 and 0.3256, respectively, indicate a significant gap from the ideal solution, making them less suitable as priority choices. Overall, schemes with higher relative closeness should be considered preferentially in practical applications, as they excel across multiple evaluation indicators. This analysis method, by quantifying the closeness of each scheme to the ideal state, provides a scientific and objective basis for decision-making, aiding in the optimal scheme selection of the innovative teaching methods.

Table 4. Relative closeness and ranking results from different methods

Sample ID	Relative Closeness (TOPSIS)	Relative Closeness (Grey Relational Degree-TOPSIS)	TOPSIS Ranking	Grey Relational Degree-TOPSIS Ranking
1	0.6533	0.5542	4	4
2	0.3954	0.4789	6	5
3	0.8134	0.5985	2	2
4	0.8945	0.6512	1	1
5	0.4267	0.4326	5	6
6	0.0791	0.3256	8	8
7	0.7642	0.5784	3	3
8	0.0142	0.2986	9	9
9	0.2217	0.4012	7	7

Table 4 displays the calculated relative closeness and ranking results using the TOPSIS and gray relational degree-TOPSIS methods. The data reveals that Sample ID 4 exhibits the highest relative closeness in both methods, with values of 0.8945 and 0.6512, respectively. The sample is consistently ranking first, indicating that this scheme is closest to the ideal solution. Sample ID 3 follows with a relative closeness of 0.8134 in the TOPSIS method and 0.5985 in the gray relational degree-TOPSIS method, consistently ranking second. Sample ID 7 is ranked third in both methods, with relative closeness values of 0.7642 and 0.5784, respectively. The lowest ranks are for Sample ID 8, with relative closeness values of 0.0142 and 0.2986 in TOPSIS and gray relational degree-TOPSIS, respectively. Both of them are ranked ninth.

Analysis of the data from Table 4 indicates discrepancies in the ranking results between the two methods. Sample ID 4 demonstrates the highest relative closeness in both methods, confirming it as the optimal scheme with the highest priority. Sample IDs 3 and 7 also perform well in both methods, which are ranked among the top, indicating that these schemes perform well across multiple evaluation indicators and should be considered preferentially. Conversely, Sample IDs 8 and 6 show the lowest relative closeness in both methods, indicating a significant gap from the ideal solution and making them less suitable as priority choices. Overall, the gray relational degree-TOPSIS method effectively quantifies the closeness of each scheme to the ideal state, providing a scientific and objective basis for decision-making and aiding in the optimal scheme selection of the innovative teaching methods.

6 CONCLUSION

A systematic decision analysis method was proposed in this study, aiming to enhance the evaluation and selection process of innovative teaching methods in information technology education. This study encompasses three main aspects: Firstly, an evaluation indicator system for innovative teaching methods in information technology education was established, covering multiple dimensions including teaching content, learning experiences, and technological application effectiveness, thereby providing comprehensive and scientific support for subsequent decision analysis. Secondly, the proximity of each teaching method to the ideal state was quantified through a scale analysis based on gray relational degree, enhancing the objectivity and accuracy of evaluations. Lastly, the detailed explication of the computational steps of the innovative teaching method decision model offered a scientific and practical tool for educational administrators and decision-makers, facilitating more informed decision-making in the selection of innovative teaching methods.

The effectiveness and reliability of this decision-analysis method were validated by experimental results. The importance of each evaluation indicator was determined through analysis of the target layer judgment matrix and the overall ranking weights from the AHP. The weight solution method based on game theory further balanced the weight distribution of each indicator, making the evaluation results more comprehensive and scientific. The analysis of relative closeness to the ideal solution for each scheme demonstrated the proximity of different teaching methods to the ideal state, providing a clear basis for ranking. A comparison of the relative closeness and ranking results from different methods further validated the consistency and reliability of the method.

The value of this study lies in providing a scientific and comprehensive evaluation and decision-making tool for selecting innovative teaching methods in information technology education, which assists in enhancing teaching quality and student learning experiences. However, this study also has certain limitations, such as the possibility that the constructed evaluation indicator system may not cover all practical teaching scenarios and that the data collection and analysis process may be influenced by subjective factors. Future study directions could include further optimizing the evaluation indicator system, validating it with more practical cases, and exploring more advanced data analysis technologies, such as big data and artificial intelligence, thereby enhancing the precision and applicability of decision analysis. By continuously refining and optimizing, it is expected to provide more reliable and practical decision support for the educational field.

7 REFERENCES

- [1] I. Kostikova, L. Holubnycha, T. Besarab, O. Moshynska, T. Moroz, and I. Shamaieva, "Chat GPT for professional English course development," *International Journal of Interactive Mobile Technologies (IJIM)*, vol. 18, no. 2, pp. 68–81, 2024. <https://doi.org/10.3991/ijim.v18i02.46623>
- [2] S. Marmoah, Supianto, F. Sukmawati, J. I. S. Poerwanti, and Yantoro, "The elementary school teachers adoption of learning management system: A UTAUT model analysis," *Ingénierie des Systèmes d'Information*, vol. 29, no. 2, pp. 715–722, 2024. <https://doi.org/10.18280/isi.290233>

- [3] M. I. Zakaria, M. F. Abdul Hanid, and R. Hassan, "Combination of M-learning with problem based learning: Teaching activities for mathematics teachers," *International Journal of Interactive Mobile Technologies (ijIM)*, vol. 17, no. 9, pp. 4–19, 2023. <https://doi.org/10.3991/ijim.v17i09.38663>
- [4] M. Zulqarnain and M. Saqlain, "Text readability evaluation in higher education using CNNs," *Journal of Industrial Intelligence*, vol. 1, no. 3, pp. 184–193, 2023. <https://doi.org/10.56578/jii010305>
- [5] Q. Li, "Empowering financial management in educational institutions: A multi-objective decision-making system using intelligent fuzzy logic algorithm and digital marketing," *Computer-Aided Design & Applications*, vol. 21, no. S4, pp. 198–210, 2024. <https://doi.org/10.14733/cadaps.2024.S4.198-210>
- [6] Y. Du, "Application of the data-driven educational decision-making system to curriculum optimization of higher education," *Wireless Communications and Mobile Computing*, vol. 2022, no. 1, 2022. <https://doi.org/10.1155/2022/5823515>
- [7] F. Y. Cao, Y. T. Feng, and B. Wei, "Practical research of online teaching platform on reform of computer network with flipped classroom," *Review of Computer Engineering Studies*, vol. 9, no. 2, pp. 67–70, 2022. <https://doi.org/10.18280/rces.090204>
- [8] J. Lu and A. Zhang, "Exploring and practicing of the advanced learning teaching in new engineering education with the assistance of information technology-based on the course of 'microcontroller principle and application technology'," in *2023 42nd Chinese Control Conference (CCC)*, 2023, pp. 1–5. <https://doi.org/10.23919/CCC58697.2023.10239719>
- [9] M. Bhatia, P. Manani, A. Garg, S. Bhatia, and R. Adlakha, "Mapping mindset about gamification: Teaching learning perspective in UAE education system and Indian education system," *Revue d'Intelligence Artificielle*, vol. 37, no. 1, pp. 47–52, 2023. <https://doi.org/10.18280/ria.370107>
- [10] X. Wu, "Reform and innovation of ideological and political education teaching mode in colleges and universities in the context of information technology empowerment," *Applied Mathematics and Nonlinear Sciences*, vol. 9, no. 1, pp. 1–15, 2024. <https://doi.org/10.2478/amns-2024-0837>
- [11] L. Liu, "Current situation and innovative methods of brass music teaching based on network information technology," *J. Electrical Systems*, vol. 20, no. 1, pp. 294–312, 2024. <https://doi.org/10.52783/jes.683>
- [12] L. Zheng and K. Chen, "Innovative practice of physical education teaching in colleges and universities in the context of 'digital' education," *Applied Mathematics and Nonlinear Sciences*, vol. 9, no. 1, pp. 1–15, 2024. <https://doi.org/10.2478/amns.2023.2.01562>
- [13] H. Yan, "Research on innovative model of piano informatization teaching under the background of big data and soft computing," *Journal of Computational Methods in Sciences and Engineering*, vol. 23, no. 5, pp. 2425–2435, 2023. <https://doi.org/10.3233/JCM-226810>
- [14] J. Tian and G. He, "Research on innovative teaching to enhance the employability of college students based on the 'five links and six steps' method," *Ain Shams Engineering Journal*, vol. 15, no. 5, p. 102677, 2024. <https://doi.org/10.1016/j.asej.2024.102677>
- [15] J. Wang and H. Yang, "Research on online evaluation method of MOOC teaching quality based on decision tree-based big data classification," *Int. J. of Cont. Engineering Education and Life-Long Learning*, vol. 33, no. 1, pp. 10–22, 2023. <https://doi.org/10.1504/IJCELL.2023.127848>
- [16] L. Liwei, "An intelligent decision methodology for triangular Pythagorean fuzzy MADM and applications to college English teaching quality evaluation," *Journal of Intelligent Systems*, vol. 32, no. 1, p. 20230074, 2023. <https://doi.org/10.1515/jisys-2023-0074>
- [17] X. Jia, "Exploring the teaching path of English teaching courses in colleges and universities based on decision tree modeling," *Applied Mathematics and Nonlinear Sciences*, vol. 9, no. 1, pp. 1–18, 2024. <https://doi.org/10.2478/amns-2024-0236>

- [18] M. Wang, “Analyzing the influence of college aesthetic education teaching on college students’ innovation ability and artistic literacy based on decision tree classification model,” *Mobile Information Systems*, vol. 2022, no. 1, 2022. <https://doi.org/10.1155/2022/9587049>
- [19] J. Huo, W. Zhang, and Z. Chen, “Enhanced decision-making through an intelligent algorithmic approach for multiple-attribute college English teaching quality evaluation with interval-valued intuitionistic fuzzy sets,” *International Journal of Knowledge-Based and Intelligent Engineering Systems*, vol. 28, no. 2, pp. 279–294, 2024. <https://doi.org/10.3233/KES-230299>

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