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Application Entropy Weight and TOPSIS Method in English Teaching Quality Evaluation of "Smart Classroom"

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Abstract

INTRODUCTION: Based on TOPSIS (Technological Ordering of Superiority and Inferiority) and entropy weight method, it aims to evaluate the quality of intelligent classroom English teaching. The brilliant classroom teaching model has attracted much attention for its highly interactive, personalized, and real-time feedback features; however, how to accurately evaluate the quality of intelligent classroom teaching remains a challenge.
OBJECTIVES: To combine the TOPSIS and entropy weight methods in practical application and consider the index ordering and weight calculation comprehensively to arrive at the quality evaluation results of each brilliant classroom teaching.
METHODS: The TOPSIS method is first used to rank multiple indicators of teaching quality to determine the optimal teaching quality. The TOPSIS method can consider the interrelationships between the hands and find the solution closest to the positive ideal solution and farthest away from the negative perfect solution by calculating each indicator's positive and negative perfect solutions. Then, the weight of each hand is calculated by combining the entropy weight method. The entropy weight method can consider the indicators' information and differences and measure the degree of their contribution to the evaluation results by calculating the entropy value of the hands.
RESULTS: The results show that the method can comprehensively consider the correlation and weight of multiple indicators, provide teachers and educational administrators with accurate teaching quality evaluation and improvement suggestions, and thus promote the optimization and enhancement of innovative classroom teaching.
CONCLUSION: By analyzing the actual smart classroom teaching data, the Author found that the method can effectively evaluate the quality of intelligent classroom teaching and provide valuable guidance for English teaching improvement.

Keywords: smart classroom, entropy weight, TOPSIS method, English teaching quality, optimization and improvement

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1 Introduction

In modern education, the "smart classroom," a new model integrating information technology and teaching[1-3], is widely used in all levels and types of schools. As a new teaching mode, the intelligent classroom has recently attracted much attention from researchers.

Some large education technology companies have developed a variety of intelligent classroom platforms that provide rich teaching resources and tools for teachers and students[4-5]. Current research focuses on instructional design and strategies for brilliant classrooms, with researchers exploring using intelligent classroom technologies and platforms to implement teaching models such as personalized teaching, independent learning, and cooperative learning[6-7]. In addition, studies focus on utilizing instructional data and learning analytics to guide instruction effectively. Unlike conventional teaching in the smart classroom, the role and ability of teachers have changed to some extent. The role of teachers in the smart classroom has changed to become a novel place, changing from a knowledge transmitter to a learner who guides learners and provides support and guidance, which in turn requires teachers to have specific technological skills to flexibly utilize the technologies and platforms of the smart classroom for teaching. Due to the unique characteristics of the smart classroom, researchers have also begun to pay attention to the degree of learner participation and feedback mechanisms in the smart classroom, and studies have shown that the intelligent classroom can increase students' motivation and participation and stimulate students' interest in learning. At the same time, learners' feedback provides teachers valuable information about teaching effectiveness [8-10].

Through the above, the effect evaluation and quality assurance of smart classrooms is an essential direction of the current research. The rest of the study is to ensure the superior development of teaching quality, so researchers have proposed a variety of evaluation indexes and methods, such as the teaching quality evaluation model, the evaluation of learning outcomes, and so on[11-13], which aims to assess the teaching effect and learning outcomes of the smart classroom.

However, how to evaluate and improve the teaching quality of a "smart classroom" has become an important issue. To solve this problem, this paper introduces the entropy weight and TOPSIS methods as standard evaluation methods to evaluate the teaching quality of a "smart classroom." The entropy weight method and TOPSIS method, two traditional multi-indicator decision-making methods, can be used to assess the teaching quality of a smart classroom. The entropy weight method calculates the information entropy between indicators to determine the weights to realize the hands' ranking and the consequences. The TOPSIS method calculates the distance between indicators to determine the order of advantages and disadvantages of the indicators and the practical application of the situation in the example analysis. In this paper, the Author will introduce the entropy weight and TOPSIS methods and discuss their application in evaluating the teaching quality of a "smart classroom."

2 Teaching Quality Evaluation Modeling or the "Smart Classroom"

2.1 Establishment of an evaluation indicator system

In this paper, the selection of evaluation indicators is carried out in the following aspects: screening the most representative and measurable indicators based on the importance and operability of critical factors, which should be able to reflect the achievement of the objectives accurately and can be improved within a specific range; evaluating the selected indicators to understand the achievement of the goals and make necessary adjustments, which can be realized through the establishment of a data collection and reporting mechanism. Such indicators can be recognized by establishing data collection and reporting means. Based on the assessment results, continuous improvements and optimization can be made, and future enhancements will involve adjusting the indicator set, improving data collection methods, and optimizing processes.

Considering the above factors and related scholars' research, the Author constructs the teaching quality evaluation index system of a "smart classroom," as shown in the following figure[14-15]. The data used in this study mainly come from the survey of different classes in a school.

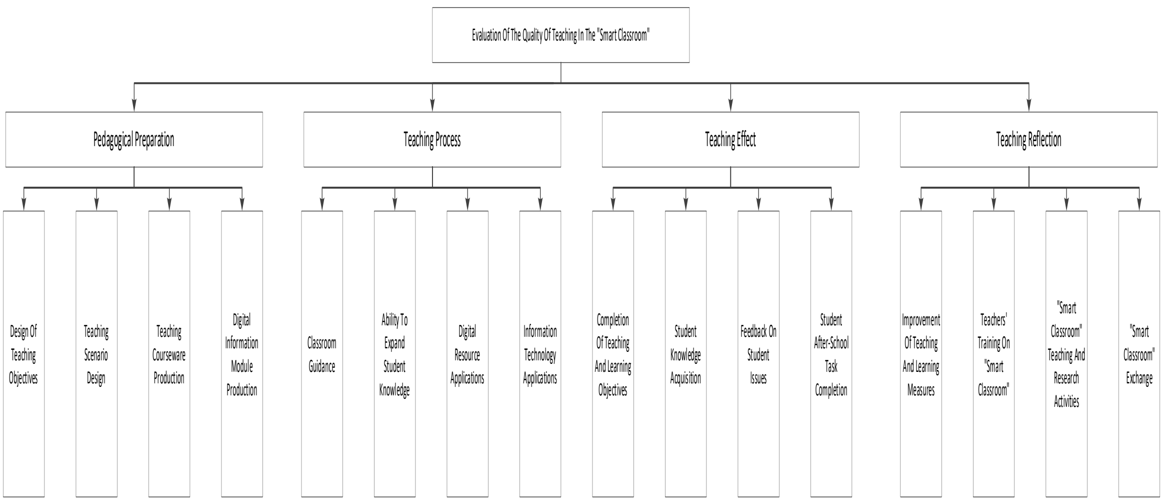

Figure 1 Teaching Quality Evaluation Index system

2.2 Entropy Weighted TOPSIS Modeling

2.2.1 Entropy weight method

First, the entropy weight method can be used to determine the weights of the evaluation indexes of teaching quality in the smart classroom. In the intelligent classroom, teachers' teaching level, students' learning achievement, and the teaching process's effect are important evaluation indexes. Moreover, the weights of these indicators can be determined by the entropy weight method. By collecting relevant data, the entropy value of each index is calculated, and then the entropy value is transformed into weights to determine each index's relative importance.

The Entropy Weight Method (EWM) is a multi-criteria decision-making method for determining the weights of indicators. The technique was first proposed by American scholar JayForrester in 1960 and has been further studied and improved by many scholars. The entropy weight method is based on information entropy, a measure of the difference between indicators. The larger the entropy, the larger the difference, the smaller the weight of the indicator; the smaller the entropy, the smaller the difference, the larger the indicator's weight should be. Therefore, the entropy weight method determines the importance of each indicator by calculating its entropy value[16-17]. The advantage of the entropy weight method is that it considers the differences between indicators and can objectively assess the importance of indicators. At the same time, the technique is simple to calculate and easy to operate. However, the entropy weight method also has some limitations, such as higher sensitivity to data and higher standardization requirements for the decision matrix. Therefore, this paper makes adjustments to the standardization equation of the entropy weight method.

Specifically, the steps of the entropy power method are as follows:

(1) Standardization of evaluation sample data

Sample data standardization refers to transforming raw data into standard, normally distributed data with specific means and standard deviations. Through standardization, variables of different scales, units, and ranges can be comparable for better data analysis and modeling.

In this paper, considering retaining the data distribution characteristics, reducing the impact of outliers, and facilitating the establishment of models, the following equation is used for standardization, and the standardized treatment isr_{ij}. The standardization process is as follows.

Standardized as follows:

$$r_{ij} = \frac{x_{ij} - min(x_j)}{max(x_j) - min(x_j)} \tag{1}$$

Equation: $max(x_j)$ -Maximum value of sample single indicator data;

$min(x_j)$-Sample single-indicator data minimum.

(2) Calculating information entropy.

$$E_j = -\frac{1}{lnm}\sum_{i=1}^{m} p_{ij} lnp_{ij} \tag{2}$$

Where: m- represents the number of calculation samples. In this paper, the calculation sample is 5;

p_{ij}-computing the median information entropy.

(3) Calculation of weights β_i（ω）.

$$\beta_i = \frac{1 - E_j}{\sum_{j=1}^{n}(1 - E_j)} \tag{3}$$

2.2.2 TOPSIS model

The TOPSIS method can be used to evaluate the teaching quality of the smart classroom. TOPSIS calculates the distance between each indicator and the optimal and worst solutions. Then, it determines the order of superiority of the hands according to the distance size [18-19]. In the imaginative classroom, the value of each indicator can be compared with the optimal solution and the worst solution to calculate the distance score and then sorted according to the score to find the optimal teaching quality program, that is to calculate the distance between each evaluation object and the reference point, the closer to the optimal end or the further away from the worst point indicates that the comprehensive characteristics of the evaluated object are better.

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is a commonly used multi-criteria decision-making method for evaluating and ranking the advantages and disadvantages of individual solutions. The process was proposed by Hwang and Yoon in 1981 and has been widely used in decision analysis, supply chain management, investment appraisal, etc.[20-21] The TOPSIS method focuses on two concepts: ideal solution and negative ideal solution. The ideal solution is the solution that achieves the maximum value (for benefit-based indicators) or the minimum value (for cost-based hands) for each indicator and represents the most desirable situation. The negative ideal solution is the scenario that achieves the minimum (for benefit-based indicators) or maximum (for cost-based hands) value on each indicator, representing the least perfect situation.

The advantage of the TOPSIS method is that it can synthesize the weights of each index and the similarity between the scheme and the ideal solution and get a comprehensive assessment result. Meanwhile, the method is simple to calculate and easy to operate. However, the TOPSIS method also has some limitations, such as the determination of the weights is subjective; considering this, this paper adopts the objective assignment method-entropy weight method for the conclusion of the importance to make up for the errors brought by the calculation of the weights in the TOPSIS method[22-23].

Given that this paper has standardized the indicator data in calculating the entropy weight, the TOPSIS method does not need to standardize the data again, while this paper adopts the entropy weight method to calculate the indicator weights, so the subsequent evaluation steps are shown below:

(1) Calculate the weighted data matrix

$$e_{ij} = \omega_j r_{ij} \tag{4}$$

(2) Calculate the distance between the weighting matrix and the most value

After processing, people can form a data matrix

$$R = \left(e_{ij}\right)_{m\times n} \tag{5}$$

Define the maximum value of each indicator, i.e., each column, ase_j^+

$$e_j^+ = max\left(e_{1j} \cdots e_{nj}\right) \tag{6}$$

Define the maximum value of each indicator, i.e., each column,

$$e_j^- = max\left(e_{1j} \cdots e_{nj}\right) \tag{7}$$

Define the distance of the ith object from the maximum value asd_i^+

$$d_i^+ = \sqrt{\sum_{j=1}^{n}\left(e_j^+ - r_{ij}\right)^2} \tag{8}$$

Define the distance of the ith object from the maximum value

$$d_i^- = \sqrt{\sum_{j=1}^{n}\left(e_j^- - r_{ij}\right)^2} \tag{9}$$

(3) Calculation of scores

$$Score_i = \frac{d_i^-}{d_i^- + d_i^+} \tag{10}$$

3 Teaching Quality Evaluation of "Smart Classroom" Based on Entropy Weighted TOPSIS Modeling

3.1 Data sources

Considering the "smart classroom," teaching quality evaluation tends to be feedback preparation, so the data used in this paper are derived from statistical data, data from the main questionnaires, and other forms of obtaining for the teaching preparation of indicators by the other teachers hired by the teachers of the research object of the teacher's lesson plans, etc. scoring, the teaching process indicators by the teachers and students to participate in the survey. Teachers and students investigate the teaching process indicators by the teachers and students to investigate the teaching effect on student feedback as the primary form of investigation for teaching reflection by the school related to determining the scoring. This paper, for comparison, uses five teachers of "smart classroom teaching" for this paper's case study; to carry out specific elaboration, this paper will be the teaching quality evaluation results to [0, 1] for the interval for the display, 1 for the optimal, 0 for the least optimal, based on which the teaching quality evaluation sort, to determine the advantages and disadvantages of teaching methods and methods of improvement. Among them, when conducting the questionnaire survey, considering the perception of the survey scoring, using 0-10 for index scoring. The final results of the study are shown in Table 1.

Table 1 Survey data table

Norm	Teacher 1	Teacher 2	Teacher 3	Teacher 4	Teachers 5
Design Of Instructional Objectives	7	8	7	8	8
Instructional Scenario Design	8	8	6	7	8
Teaching Courseware Production	6	7	9	8	7
Digital Information Module Production	7	7	8	7	7
Classroom Citation	8	8	8	7	7
Students' Ability To Expand Their Knowledge	8	8	9	7	8
Digital Resource Applications	7	8	8	8	8
Information Technology Applications	6	7	6	8	8
Completion Of Teaching Objectives	8	6	7	8	7
Student Knowledge Acquisition	8	7	7	7	7
Feedback On Student Issues	7	7	6	7	6
Student After-School Task Completion	7	7	6	7	8
Improvement Of Teaching And Learning Measures	6	7	7	8	7
Teachers' Training On "Smart Classroom"	7	8	6	7	7
"Smart Classroom" Teaching And Research Activities	8	7	7	6	7
"Smart Classroom" Exchange	8	7	7	7	6

A single-indicator score mapping was conducted, as shown in Figure 2.

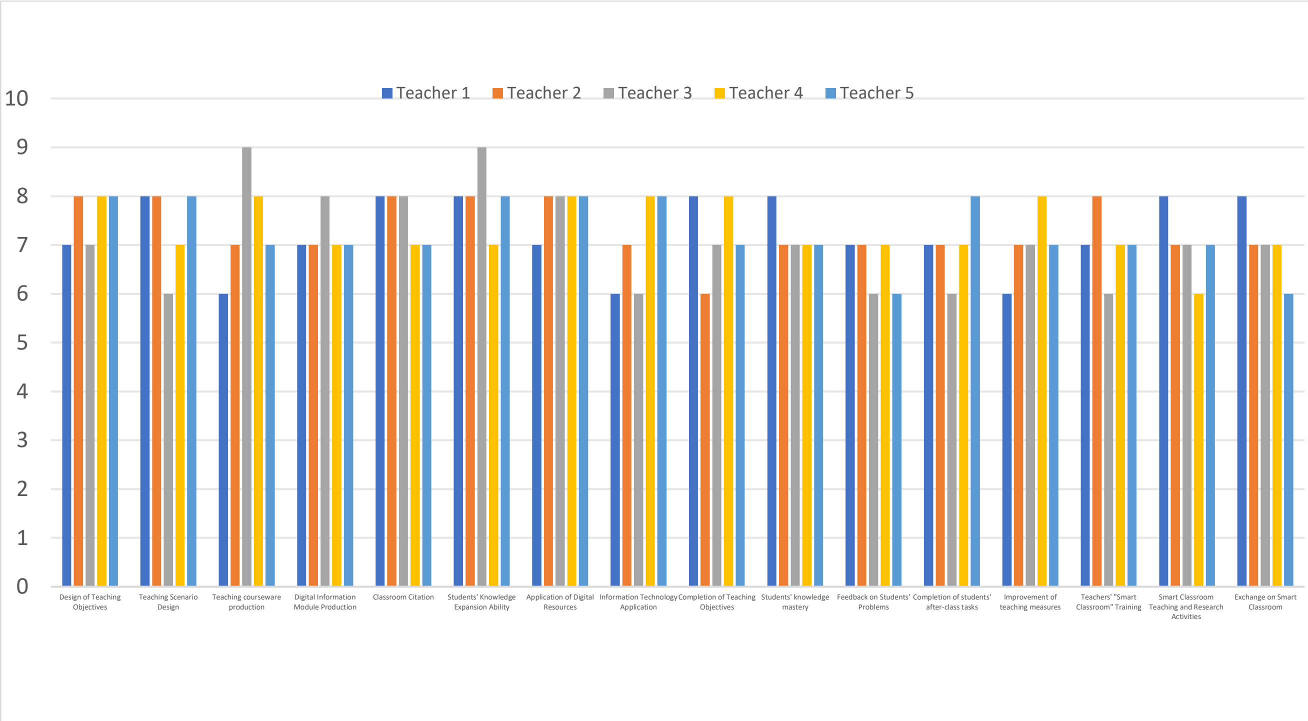

Figure 2 Statistical Chart

Based on Figure 2, it can be seen that due to the age difference of the five selected teachers and the differences in their understanding and application of the "smart classroom," there is a certain degree of reflection in some indicators. For example, the third teacher scored higher in teaching visible production. After analyzing, the teacher has much knowledge about using the Internet and intelligent teaching aids during the study period, so the score is high. In the area of student's ability to expand their knowledge, the mastery of new resources is beneficial to the growth of student's knowledge, and the integration of classroom knowledge and extracurricular knowledge is a positive development.

3.2 Determination of indicator weights based on the entropy weight method

Through equation (1) - equation (3) to determine the weight of the indicators, which indicator data selected from the survey data in section 3.1 of this paper, through the actual data for the determination of the weight, the advantage of this is that the statistical data can be continuously expanded, and ultimately will be the more and more objective response to the degree of importance of the indicators, and ultimately tends to be a certain degree of stability, for the follow-up of the "intelligent classroom "Teaching quality evaluation has played a particular role in the database.

This paper lists the standardized data and entropy weight method to calculate the median value, information entropy, and weights in Table 2, Table 3, and Table 4, respectively, as follows.

Table 2 Standardized data processing results

Norm	Teacher 1	Teacher 2	Teacher 3	Teacher 4	Teachers 5
Design Of Instructional Objectives	0.0020	1.0000	0.0020	1.0000	1.0000
Teaching Scenario Design	1.0000	1.0000	0.0020	0.5010	1.0000
Teaching Courseware Production	0.0020	0.3347	1.0000	0.6673	0.3347
Digital Information Module Production	0.0020	0.0020	1.0000	0.0020	0.0020
Classroom Citation	1.0000	1.0000	1.0000	0.0020	0.0020
Students' Ability To Expand Their Knowledge	0.5010	0.5010	1.0000	0.0020	0.5010
Digital Resource Applications	0.0020	1.0000	1.0000	1.0000	1.0000
Information Technology	0.0020	0.5010	0.0020	1.0000	1.0000

Applications					
Completion Of Teaching Objectives	1.0000	0.0020	0.5010	1.0000	0.5010
Student Knowledge Acquisition	1.0000	0.0020	0.0020	0.0020	0.0020
Feedback On Student Issues	1.0000	1.0000	0.0020	1.0000	0.0020
Student After-School Task Completion	0.5010	0.5010	0.0020	0.5010	1.0000
Improvement Of Teaching And Learning Measures	0.0020	0.5010	0.5010	1.0000	0.5010
Teachers' Training On "Smart Classroom"	0.5010	1.0000	0.0020	0.5010	0.5010
"Smart Classroom" Teaching And Research Activities	1.0000	0.5010	0.5010	0.0020	0.5010
"Smart Classroom" Exchange	1.0000	0.5010	0.5010	0.5010	0.0020

Table 3 Calculation of process values by entropy weight method

Norm	Teacher 1	Teacher 2	Teacher 3	Teacher 4	Teachers 5
Design Of Teaching Objectives	0.0007	0.3329	0.0007	0.3329	0.3329
Teaching Scenario Design	0.2855	0.2855	0.0006	0.1430	0.2855
Teaching Courseware Production	0.0009	0.1431	0.4276	0.2853	0.1431
Digital Information Module Production	0.0020	0.0020	0.9921	0.0020	0.0020
Classroom Citation	0.3329	0.3329	0.3329	0.0007	0.0007
Students' Ability To Expand Their Knowledge	0.2000	0.2000	0.3992	0.0008	0.2000
Digital Resource Applications	0.0005	0.2499	0.2499	0.2499	0.2499
Information Technology Applications	0.0008	0.2000	0.0008	0.3992	0.3992
Completion Of Teaching Objectives	0.3329	0.0007	0.1668	0.3329	0.1668
Student Knowledge Acquisition	0.9921	0.0020	0.0020	0.0020	0.0020
Feedback On Student Issues	0.3329	0.3329	0.0007	0.3329	0.0007
Student After-School Task Completion	0.2000	0.2000	0.0008	0.2000	0.3992
Improvement Of Teaching And Learning Measures	0.0008	0.2000	0.2000	0.3992	0.2000
Teachers' Training On "Smart Classroom"	0.2000	0.3992	0.0008	0.2000	0.2000
"Smart Classroom" Teaching And Research Activities	0.3992	0.2000	0.2000	0.0008	0.2000
"Smart Classroom" Exchange	0.3992	0.2000	0.2000	0.2000	0.0008

Table 4 Information entropy and weight calculation results

Norm	Information Entropy	Weights
Design Of Teaching Objectives	0.6886	0.0638
Teaching Scenario Design	0.8425	0.0323
Teaching Courseware Production	0.7975	0.0415
Digital Information Module Production	0.0356	0.1976
Classroom Citation	0.6886	0.0638
Student Knowledge Expansion Skills	0.8313	0.0346
Digital Resource Applications	0.8636	0.0280

Information Technology Applications	0.6626	0.0691
Completion Of Teaching Objectives	0.8292	0.0350
Student Knowledge Acquisition	0.0356	0.1976
Feedback On Student Issues	0.6886	0.0638
Student After-School Task Completion	0.8313	0.0346
Improvement Of Teaching And Learning Measures	0.8313	0.0346
Teachers' Training On "Smart Classroom"	0.8313	0.0346
"Smart Classroom" Teaching And Research Activities	0.8313	0.0346
"Smart Classroom" Exchange	0.8313	0.0346

Plot the weighting results as shown in Figure 3.

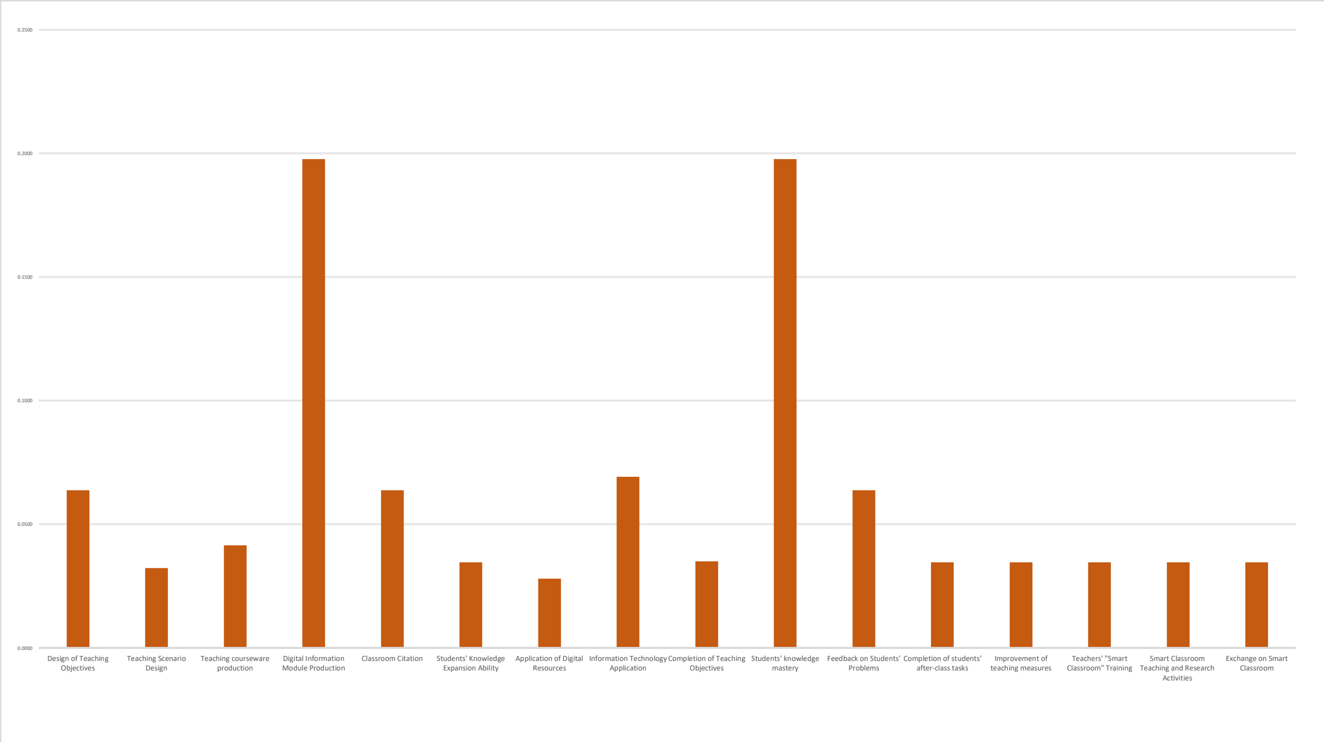

Figure 3 Graph of weighting results

Based on the above weight calculation table and weight result chart, producing the indicator digital information module is essential. After analysis, it can be concluded that the digital information module of the digital intelligent classroom indicator has a vital role in teaching, which provides quantitative data for students and teachers to assess the learning process and results and can visually display the performance and progress of the students. Students learn, discover their weaknesses and problems, and take timely and appropriate teaching measures. It can provide more challenging tasks for students who learn faster, offer more tutoring and support for students with learning difficulties, and help teachers personalize their teaching and motivate students to learn. This shows that the intelligent classroom can improve teaching effectiveness and students' learning outcomes.

In addition, students' knowledge mastery is also weighted more heavily. It is evident that no matter what method of teaching is used, the most crucial purpose is that students can master knowledge and apply it. In conclusion, the importance of students' knowledge mastery is that mastering understanding can improve their academic performance and learning ability, develop problem-solving skills and critical thinking, promote career development, and enhance their overall quality. Therefore, teachers should emphasize the learning and mastery of students' knowledge, improve their teaching level, and enhance students' knowledge absorption ability through continuous education and practice.

3.3 Evaluation of teaching quality of "smart classroom" based on the TOPSIS method

This paper performs TOPSIS evaluation according to Equation (4)-Equation (10).

The weighting matrix is calculated according to equation (4), as shown in Table 5 below.

Table 5 TOPSIS weighting matrix

Norm	Teacher 1	Teacher 2	Teacher 3	Teacher 4	Teachers 5
Design Of Instructional Objectives	0.0262	0.0300	0.0262	0.0300	0.0300
Teaching Scenario Design	0.0155	0.0155	0.0116	0.0136	0.0155
Teaching Courseware Production	0.0149	0.0174	0.0224	0.0199	0.0174
Digital Information Module Production	0.0858	0.0858	0.0981	0.0858	0.0858
Classroom Citation	0.0300	0.0300	0.0300	0.0262	0.0262
Students' Ability To Expand Their Knowledge	0.0154	0.0154	0.0173	0.0135	0.0154
Digital Resource Applications	0.0112	0.0128	0.0128	0.0128	0.0128
Information Technology Applications	0.0263	0.0307	0.0263	0.0351	0.0351
Completion Of Teaching Objectives	0.0173	0.0130	0.0151	0.0173	0.0151
Student Knowledge Acquisition	0.0981	0.0858	0.0858	0.0858	0.0858
Feedback On Student Issues	0.0302	0.0302	0.0259	0.0302	0.0259
Student After-School Task Completion	0.0154	0.0154	0.0132	0.0154	0.0176
Improvement Of Teaching And Learning Measures	0.0132	0.0154	0.0154	0.0176	0.0154
Teachers' Training On "Smart Classroom"	0.0154	0.0176	0.0132	0.0154	0.0154
"Smart Classroom" Teaching And Research Activities	0.0176	0.0154	0.0154	0.0132	0.0154
"Smart Classroom" Exchange	0.0176	0.0154	0.0154	0.0154	0.0132

Table 5 shows that the same teacher with the same score for different indicators can not see the overall quality of teaching; that is, it is not possible to judge the general level of teaching quality of teachers in the "smart classroom" after weighting the same score for different indicators reflects the difference, which thoroughly explains that the importance of additional indicators for the overall evaluation of the results of the existence of a specific difference, not generalized, which fully demonstrates that the significance of different indicators for the comprehensive assessment results has a particular difference and cannot be generalized, and also reflects that the use of entropy weighting method to calculate the weight of indicators is reasonable and feasible, and has a specific complementary effect on the TOPSIS evaluation method to make up for the defects of the subjective self-weighting.

The calculation of the relevant defined values is shown in Table 6.

Table 6 Calculated values for relevant data

Norm	Teacher 1	Teacher 2	Teacher 3	Teacher 4	Teachers 5
D+Vector	0.0182	0.0196	0.0182	0.0193	0.0200
D-Vector	0.0164	0.0115	0.0160	0.0139	0.0125

The final score was calculated as shown in Table 7.

Table 7 Evaluation results

Norm	Appraise Value
Teacher 1	0.4736
Teacher 2	0.3690
Teacher 3	0.4675
Teacher 4	0.4183
Teachers 5	0.3851

Table 6 shows the results of evaluating the five teachers' teaching quality, of which the optimal value is 1. So in the evaluation of the matter, the closer to 1, the higher the quality of teaching in the "smart classroom," as can be seen in the table above, the quality of education of the five teachers is evaluated as the best results of the teacher 1, and ranked behind is teacher 2. As shown in Figure 4.

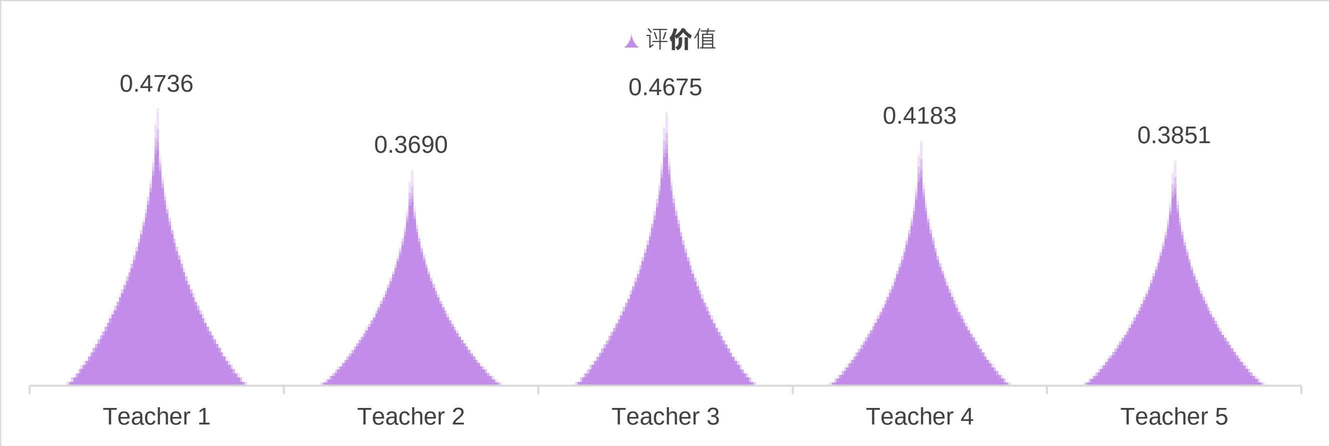

Figure 4 Map of evaluation results

Table 7 shows the overall ranking of the evaluation of the five teachers' teaching quality, and the results are analyzed in conjunction with the statistical data in Table 1 and the weighted data in Table 5.

For the first-ranked teacher 1, it can be seen that the teacher's design of teaching scenarios, classroom references, students' ability to expand their knowledge, the fulfillment of teaching objectives, and ultimately, students' knowledge mastery are all rated at a higher value, and the teacher actively participates in innovative classroom training. Exchange, and constantly improve their ability, so the rating value is high, but its teaching visible production, information technology applications have certain shortcomings, still need to improve.

The above data and calculations show the need for targeted improvement of specific indicators but also reflect the focus and difficulties of the "smart classroom." for example, the intelligent classroom needs to rely on technological equipment and the network for teaching. Teachers and students must familiarize themselves with and master the relevant technical operations and troubleshooting, such as electronic whiteboards, projectors, student clickers, and other equipment. The smart classroom requires teachers to carry out instructional design and the development of teaching resources, including the formulation of course objectives, plan of teaching activities, and selection of teaching resources. Teachers must understand how to effectively utilize innovative classroom technology tools to support teaching and learning activities and design appropriate teaching content according to students' needs and interests. The intelligent classroom aims to increase student participation and interaction, but students may need help with new teaching modes or be unfamiliar with relevant technology tools. Teachers must actively guide and stimulate students' interest, encourage students to actively participate in classroom activities, and improve students' learning outcomes. In addition, traditional examination and assessment methods may not meet the intelligent classroom's needs, and teachers need to explore new assessment methods and tools, such as online quizzes, homework submission, and analysis.

4 Conclusions

In this paper, an example analysis is carried out based on the entropy weight method and TOPSIS, and the results prove that the evaluation method of the quality of intelligent classroom teaching based on the entropy weight method and TOPSIS method is effective. The quality of competent classroom teaching can be assessed objectively and comprehensively by evaluating multiple indicators such as teachers' teaching quality, students' learning, and teaching resource utilization. It must be clear that the entropy weight and TOPSIS methods are based on different principles for evaluation. The entropy weight method determines the consequences by calculating the entropy value of each indicator, emphasizing the relative difference between the indicators. In contrast, the TOPSIS method determines the weights based on the distance between the indicators, focusing on the absolute difference of the indicators. The two methods are complementary and can supplement each other to improve the accuracy and reliability of the evaluation results.

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