Construction of A Multi-Dimensional Achievement Evaluation System for Students in Higher Vocational Colleges

Yan Mi[1*] and Bei Qiao[2]

[1]College of Information and Control Engineering, Shandong Vocational University of Foreign Affairs, Weihai 264504, China.

Email id: [1]80419@sdws.edu.cn, [2]41980@sdws.edu.cn

Corresponding author: Yan Mi, 80419@sdws.edu.cn

Abstract. This study investigates and studies the multidimensional performance evaluation system of the teaching platform to better reflect the learning process and learning effect of students in higher vocational colleges in the flipped classroom. The evaluation application scenarios and factor structure were first examined, and the weight of each element was calculated. Second, the objective evaluation factor calculation method and the subjective evaluation factor score expression method are investigated. The assessment results of students' learning effects are then obtained through the compound calculation of the calculated results and the set evaluation ratio, and eventually, a comprehensive multi-dimensional performance evaluation system is formed. Finally, data is collected to validate the multidimensional performance evaluation system. The results demonstrate that the system can appropriately calculate the essential data to determine the final student grades.

Keywords: Vocational colleges; flipped classroom; student's result; Multidimensional Evaluation System
DOI: https://doi.org/10.14733/cadaps.2023.S12.231-244

1 INTRODUCTION

Since the 1930s, the subject of assessing pupils' learning effectiveness has quietly emerged and grown in educational circles. Many academics have done extensive research on the multidimensional evaluation system. Armstrong began by gathering data on kids' learning and evaluating their academic achievements based on their conduct. Campbell's study focuses on appraisal concepts and various appraisal methodologies. Campbell believes that evaluation involves not simply an assessment of student's academic performance, but also of students themselves. At the same time, he argues that many evaluations can capture the essence of teaching and serve as a foundation for teaching improvement. Informal testing is also highly significant because it simulates a student's

actual circumstance. According to the learning management system on student's performance, the multidimensional academic achievement exam can more fairly and accurately measure students' academic level and learning effect [10]. According to the blended learning in higher education, the multimodal evaluation is advantageous to the nurturing and development of students' potential [8]. According to the institutional e-learning policy, the conceptual interaction is the highest level of interaction and a key metric for measuring deep learning [11],[12] examined and discussed the key challenges surrounding online learning evaluation and implementation approaches. The extent of the application of various evaluation methods and specialized evaluation methods is summarized in this study. The evaluation approach based on video was investigated in the literature [5],[16] elaborated and introduced the most recent online education evaluation architecture and technologies. [4] investigated the link between online teaching conduct and learning outcomes. [2] presented and carried out an overall design on a learning-oriented fuzzy comprehensive evaluation approach. Following the mixed teaching approach, [15] employed methodologies such as questionnaire surveys and expert interviews to construct assessment indicators. [6] investigated student evaluation from the concept and characteristics of course evaluation.

In conclusion, multi-dimensional evaluation is receiving more and more attention in the contemporary educational landscape. Along with the test surface's several dimensions, there are many different test procedures, objectives, and tools. These are crucial sources to consult while developing a multi-dimensional evaluation system. Multidimensional evaluation can more accurately indicate the training effect of the institution on students while also reflecting their abilities in other areas, such as teamwork, from the standpoint of vocational education.

2 THE FOUNDATION OF MULTI-DIMENSIONAL ACHIEVEMENT EVALUATION SYSTEM CONSTRUCTION

Multi-dimensional evaluation is the term used to describe the thorough assessment of student performance in higher vocational colleges using several dimensions and multiple evaluation subjects with varying weights [13] Dimensions, content, indications, and weights can be correctly altered, added to offline evaluations, and given weights following various evaluation objectives so that the subjective and objective evaluations of the evaluation can be integrated. As a result, both horizontally and vertically many dimensions have been attained by the evaluation method, and the evaluation results are more objective. A more effective and focused evaluation method is multi-dimensional evaluation, which allows the evaluation object to choose the evaluation dimensions and scores following their requirements for a better reflection of their goals.

The use of multi-dimensional evaluation is widespread. A multi-dimensional evaluation of student performance is necessary due to the requirements of teaching platforms to support the flipped classroom of higher vocational colleges and the characteristics of SPOC courses, i.e., diversified evaluation. As a result, this paper examines the multi-dimensional performance evaluation system, which primarily reflects the learning process and learning results of students on the teaching platform, and covers its development, application scenarios, factor structure analysis, factor weight calculation, evaluation result score expression, and evaluation system verification.

To create an effective method for measuring student performance in higher vocational colleges, we must first consider the following factors: First, explore the use of information systems for network evaluation. Because multi-dimensional testing needs a lot of data and on-site paper-based evaluation has its limitations. Therefore, employing the information system to conduct online testing may effectively solve the problem by ensuring the accuracy, completeness, accuracy, timeliness, and accuracy of the data while reducing human statistical errors. Second, the dimensions, indicators, objects, and weights must be appropriate. Use as few categories and indicators as you can in the early stages of administering the multidimensional test to gain experience and better comprehend the standards of evaluation. After numerous testing's dimensions, indications, items, and weights

can be changed accordingly. Third, student evaluation needs to get careful consideration. Although the multidimensional test can reflect the situation more accurately and objectively, there are other aspects as well, such as accidental and subjective factors. As a result, there are other ways to evaluate the academic achievement of students in higher vocational colleges over a year or longer than the multidimensional test.

3 CONSTRUCTION OF A MULTI-DIMENSIONAL ACHIEVEMENT EVALUATION SYSTEM

The elements of a multi-dimensional evaluation of student performance must first be composed to conduct the evaluation; next, the scenarios for its application must be examined; finally, scoring calculation tables and standards based on each factor's characteristics must be established to translate the evaluation's statistical findings into scores; on this basis, combine the factor. Figure 1 depicts the multi-dimensional performance evaluation system's construction process. Below, each step will be thoroughly explained.

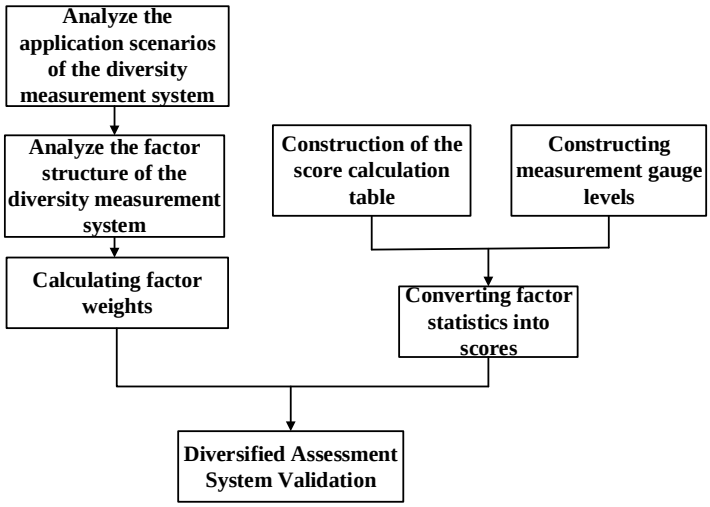

Figure 1: Schematic diagram of the construction process of the multi-dimensional performance evaluation system.

3.1 Analysis of Application Scenarios of Multidimensional Performance Evaluation

To promote the use of flipped classrooms, the evaluation process is practically used throughout the entire teaching process and is separated into three links: before class, during class, and after class. Before class, students use the teaching platform to learn, and the system records the important objective data; during class, it enables teacher-student interaction and records pertinent teaching activities objectively; following class, participants in this course evaluate subjective elements. To get the final academic performance of students, conduct evaluations to give pertinent information and statistical analysis on all data using mathematical models. The application scenario diagram for multi-dimensional performance evaluation is shown in Figure 2.

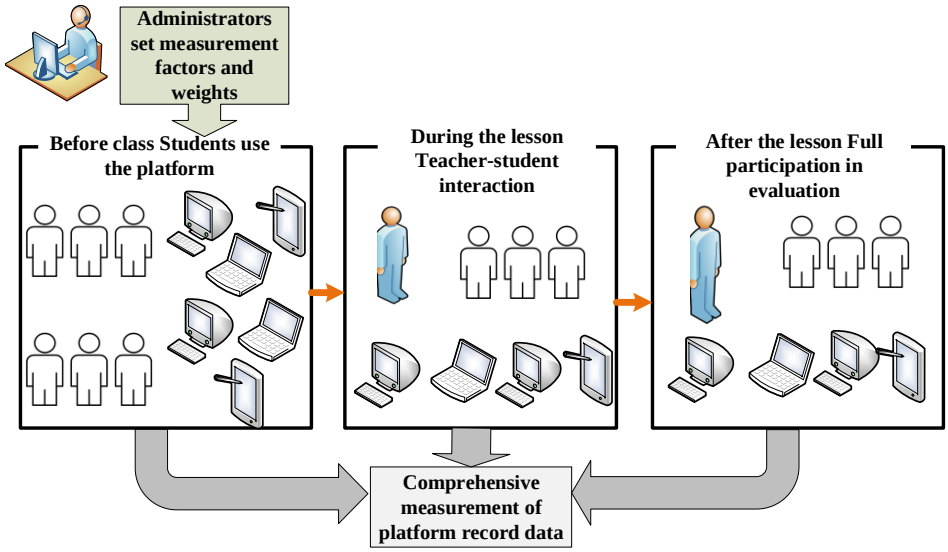

Figure 2: Application Scenario of Multi-Dimensional Performance Evaluation.

3.2 Structural Analysis of Multidimensional Performance Evaluation Factors

In the course of the inquiry, it was discovered that the multi-dimensional characteristics of the evaluation criteria for students' learning success on the teaching platform. They are first separated into subjective and objective elements based on the fundamental characteristics of each. The next step is to further separate the two into successive layers. The administrator can decide what precise components of each subjective evaluation factor will be used. As a result of the multidimensional qualities that the performance evaluation variables display. Consequently, it is important to consider how to categorize and evaluate multi-dimensional evaluation criteria to ensure that they are accurately reflected and included when creating an evaluation system. These evaluation factors can be shown in a hierarchical structure after being comprehended, analyzed, summarized, and extracted. In Figure 3, the structural analysis of the multiple-dimensional performance evaluation elements is depicted, and all evaluation variables are separated into subjective and objective categories based on the type of evaluation.

3.3 Weight Calculation of Multi-dimensional Performance Evaluation Factors

The method of merging several evaluation elements results in the multi-dimensional learning achievement evaluation system. These factors affect evaluation findings to varying degrees, and they are distributed differently throughout the evaluation system. When the evaluation system is integrated, it is required to specify the weight of each assessment element in the system for the evaluation findings to be fair and precisely reflect the actual situation of the evaluation objects. There is a hierarchical link between the assessment criteria, judging by the makeup of the aforementioned evaluation factors. To create a more logical evaluation model, this study employs the Analytic Hierarchy Process (AHP) to calculate the weights of the evaluation factors. In the 1870s, operations researcher Professor T.L. Saaty of the University of Pittsburgh made the AHP proposal [3]. Figure 4 depicts the process flow diagram for the AHP technique, which can do both qualitative and quantitative analysis in addition to having systemic qualities and a distinct hierarchy [7]. Figure 4 depicts a flowchart of the AHP procedure.

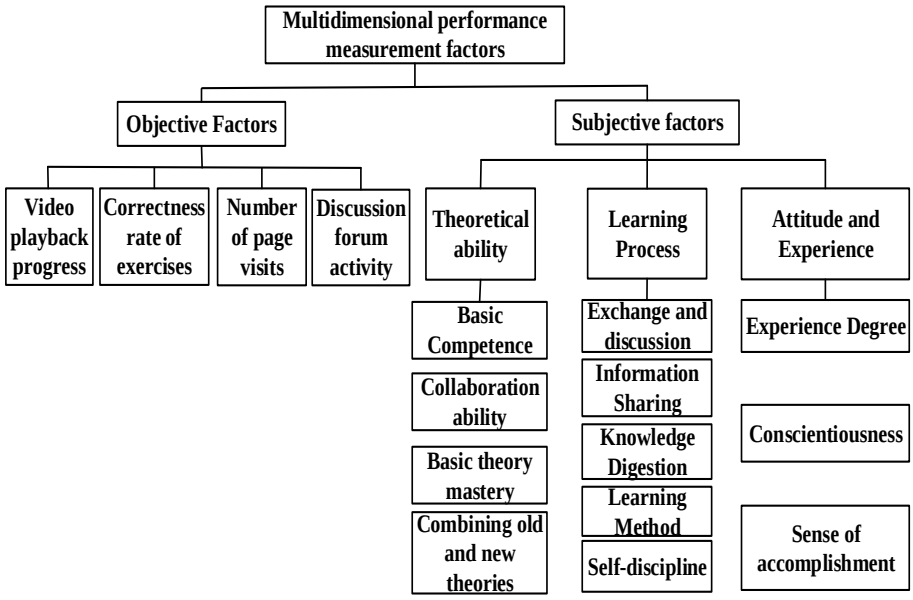

Figure 3: Structural diagram of multi-dimensional achievement evaluation factors.

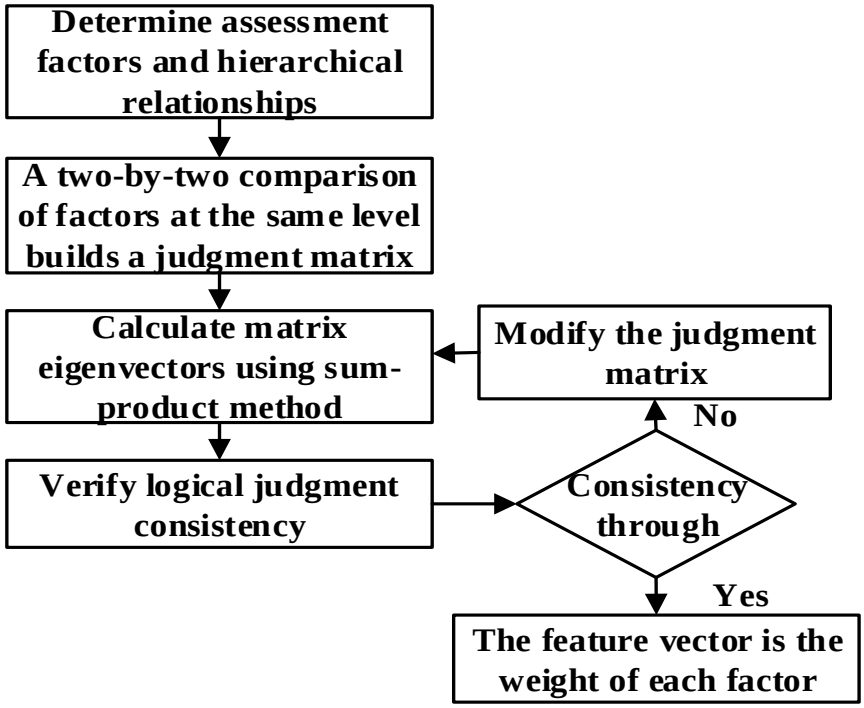

Figure 4: Schematic diagram of the process of AHP.

The specific process of AHP is as follows:

Step 1: Build a progressive hierarchy
The multi-dimensional academic performance evaluation elements are established to consist of 2 first-level evaluation factors, 7 second-level evaluation factors, and 12 third-level evaluation factors based on the structural analysis of the evaluation components in Section 3.2. The first-level evaluation factors, objective factor A and subjective factor B, account for 65% and 35%, respectively, of the results of the comprehensive evaluation, following the survey and the college's requirements. As a result, the weights of the two first-level evaluation factors are WA= 0.65 and WB=0.35. Table 1 lists the specific secondary and tertiary evaluation criteria.

Primary Factors	*Secondary factors*	*Tertiary factors*
Objective factor A	*Video playback progress A1*	
	Correctness rate of exercises A2	
	Discussion forum activityA3	
	Number of study page visits A4	
Subjective factor B	*Theoretical abilityB1*	*Basic theory mastery B11*
		Combining old and new theories B12
		Basic Competencies B13
		Collaboration ability B14
	Learning Process B2	*Learning Method B21*
		Information Sharing B22
		Exchange and discussion B23
		Self-discipline B24
		Knowledge Digestion B25
	Attitude and Experience B3	*Conscientiousness B31*
		Experience B32
		Sense of accomplishment B33

Table 1: Hierarchical structure of multi-dimensional academic performance evaluation factors.

Step 2: Pairwise comparison and establishment of judgment matrix

Set the value to γ_{ij} and use T.L. Saaty's 9-level significance scale to compare two elements [9]. System administrators and professional managers have the authority to configure assessment elements in the teaching platform. The evaluation factors' elements and their respective weights can be customized by users to suit their individual needs. To avoid affecting the system data, it is typically advised not to change the evaluation factors and weights too frequently after configuring them. For better understanding, simulated data is used to show how the test mathematical model was created below. In actual use, the system will create an evaluation mathematical model based on user requirements. After two comparisons, the judgment matrix R indicated in Eq. (3.1) is obtained by sorting the evaluation elements of the same level at the categorization level according to their relative relevance.

$$R=\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{n1} & r_{n1} & \cdots & r_{n1} \end{bmatrix} \tag{3.1}$$

Step 3: Using the sum-product method, calculate the matrix eigenvectors by the formula
The judgment matrix is normalized by column to obtain a new matrix A as shown in Eq. (3.2).

$$A=\left(a_{ij}\right)_{n^{*n}}, \quad a_{ij}=\frac{r_{ij}}{\sum_{i=1}^{n} r_{ij}} \tag{3.2}$$

Step 4: Check the consistency of the judgment matrix

For instance, it is evident that A is more essential than B if C is less significant than B and B is slightly more important than C. It is a logical unity that would be incoherent otherwise. It is required to use the method to compute the index CI , as shown in Eq. (3.3), to avoid logical conflicts in thinking and the inconsistency of judgments before and after.

$$CI=\frac{\lambda_{\max}-n}{n-1} \tag{3.3}$$

Step 5: Judgment matrix R has the consistency

The weight distribution of each assessment factor is fair if R is consistent. The weight of each assessment component is, thus, represented by the eigenvector C of the determination matrix R. The following Table 2 of subjective factor weights is produced by adding together the weights of each factor.

secondary factors	*Weights*	*tertiary factors*	*Weights*
theoretical abilityB1	*0.6*	*Basic theory masteryB11*	*0.4759*
		Combining old and new theoriesB12	*0.2884*
		Basic CompetenciesB13	*0.1544*
		Collaboration abilityB14	*0.0813*
learning processB2	*0.2*	*Learning MethodB21*	*0.3006*
		Information SharingB22	*0.2221*
		Exchange and discussionB23	*0.2171*
		Self-disciplineB24	*0.1268*
		Knowledge DigestionB25	*0.1335*
attitude and experienceB3	*0.2*	*ConscientiousnessB31*	*0.3873*
		ExperienceB32	*0.4429*
		Sense of accomplishmentB33	*0.1698*

Table 2: Multi-dimensional learning effect evaluation factors - subjective factor weight.

3.4 Score Representation of Multi-dimensional Performance Assessment Results

3.4.1. Score calculation method and unification of objective factors

The following factors are considered to have an objective impact on the evaluation outcomes in the teaching platform's evaluation system model: video playback speed, proper exercise frequency (after-class exercises plus classroom exercises), activity in the discussion area, frequency of web browsing, etc. The methodology of the various impact factor scores is provided in Table 3 below due to variations in statistical approaches.

factor	*calculation method*	*illustrate*
Video playback progress	$\frac{\text{Length of video broadcasted}}{\text{Total Video Length}} \times 100$	*When playing the same video multiple times, record the longest duration*
Exercise accuracy	$\frac{\text{Correctness rate of pre-course exercises} + \text{Correctness rate of in-class exercises}}{\text{Total number of pre-course exercises} + \text{Total number of in-class exercises}} \times 100$	*The correct rate of exercises in each class hour includes two parts before class and in class*
Forum activity	$\frac{\text{Number of posts} + \text{Number of replies}}{\text{Standard number set by the administrator}} \times 100$	*When the standard quantity is exceeded, it is divided into 100 points highest score*
Learning page visits	$\frac{\text{Number of times students visit the learning page}}{\text{Standard number set by the administrator}} \times 100$	*When the standard quantity is exceeded, it is divided into 100 points highest score*

Table 3: Calculation table of objective factor scores.

The system administrator determines the parameters required for each factor, such as the number of standards in discussion activities, following the requirements of the school, and then calculates the parameters consistently. The scores for each factor are typically combined using the percentage approach.

3.4.2. Score calculation method and unification of subjective factors

On the teaching platform, the scores of subjective criteria should be taken into account in addition to the scores of objective factors. It is not practicable for the assessment subject to score subjective aspects on the platform because the evaluation's objects are primarily students, and there are a lot of students. As a result, following analysis, it is necessary to establish factor gauges and fuzzy comprehensive assessment methods for the evaluation of subjective factors.
(1) Gauge of subjective factors

The evaluation subject must assess each of the subjective aspects that influence the evaluation outcomes individually. The teaching platform can employ assessment rubrics to appropriately quantify the subjective evaluation because the evaluation indicators are difficult to quantify, not accurate enough, and difficult to operate. This will make the evaluation findings of subjective elements more accurate and operable. Rubrics can be used in multi-dimensional academic performance evaluation to solve issues like imprecise subjective evaluation criteria and calculate students' scores. Before classes begin, the academic affairs office of the college or the teacher team can construct the rubrics following the teaching requirements of the college and the main points of the lesson material. The gauge rating table's design allows for a direct reflection of the levels and evaluation criteria for each arbitrary component. The rubric grade table's grading standards for each

subjective component can also help pupils make an intuitive comparison to their situation. To some extent, these evaluation standards serve as a guide for students learning. In addition to emphasizing the individualization of students' learning processes, the subjective factors rubric also encourages collaborative learning, places a premium on the fairness and authenticity of problems, and not only looks for learning outcomes but also pays attention to the learning process. The administrator of the system can determine the grades of each assessment rule following the demands of the school. The subjective factor gauge rating chart in Table 4 includes a theoretical ability gauge rating table. Similar to Table 4, the scales for the learning process and attitude experience are not yet entirely displayed due to space constraints.

Factors	*Measurement criteria*	*Grade*				
Basic theory mastery B11	*Good command of basic theoretical knowledge of the course*	*Perfectly in line with*	*Conformity*	*General*	*Does not meet*	*Totally out of line*
Combining old and new theories B12	*Ability to integrate learned theories with new ones*	*Perfectly in line with*	*Conformity*	*General*	*Does not meet*	*Totally out of line*
Basic Competencies B13	*Ability to learn new courses well*	*Perfectly in line with*	*Conformity*	*General*	*Does not meet*	*Totally out of line*
Collaboration abilityB14	*Ability to collaborate effectively and well with fellow students*	*Perfectly in line with*	*Conformity*	*General*	*Does not meet*	*Totally out of line*

Table 4: Subjective Factors - Rating Table of Theoretical Ability Gauge.

(2) Fuzzy comprehensive evaluation method

The evaluation object assesses the subjective elements of various learning outcomes of various pupils using various rubric grades. The quantitative scores are generated from qualitative evaluations. To meet the real computation and display criteria, this work adopts a method based on fuzzy comprehensive evaluation [1]. from qualitative evaluation to quantitative determined value. The fuzzy comprehensive evaluation approach uses the membership degree theory to identify some issues that are challenging to quantify. The membership degree of the fuzzy comprehensive assessment can be expressed by a precise number due to the complexity of the multidimensional learning achievement evaluation in the SPOC flipped classroom teaching mode. However, it can also help assessment subjects make more sensible and unbiased conclusions by providing a more accurate reflection of their inner feelings. The fuzzy comprehensive evaluation involves qualitatively synthesizing quantitative findings to produce more thorough and accurate evaluation results, hence boosting the validity of student evaluation outcomes [14]. Figure 5 depicts the flowchart for the fuzzy comprehensive evaluation approach.

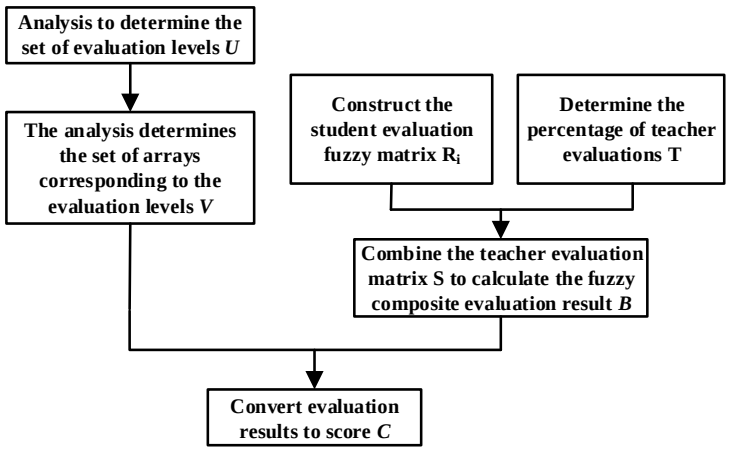

Figure 5: Schematic diagram of fuzzy comprehensive evaluation method flow chart.

Step 1: Create the evaluation level set U : The assessment level is determined as the first step in the fuzzy comprehensive evaluation procedure. The appropriateness of the grade chosen will directly affect the accuracy of the evaluation results. The grades in each gauge's grade table in 3.4.2 correspond to the fuzzy evaluation grades in the evaluation system, so the evaluation index set = extremely consistent, consistent, general, non-conforming, entirely non-conforming. The administrator can specify the level of each assessment rubric in the system evaluation rule setting;

Step 2: Find the value set V that corresponds to the evaluation level set U: Because the final calculation and display in learning evaluation generally uses a percentage system, it is necessary to correspond to the score segments represented by the five levels of fuzzy evaluation indicators, such as: very consistent (100-90), meet (89-80), general (79-70), basically meet (69-60), do not meet (59-0). Each index's specific score value is the average of the associated score segment, so the value set V corresponds to the fuzzy evaluation index set U= {95, 85, 75, 65, 35}. The administrator can set the scored segment corresponding to each assessment rubric level in the system evaluation rule configuration;

Step 3: Create a fuzzy matrix for student evaluation R: Each evaluation subject selects evaluation grades using a distinct subjective factor scale. The system obtains the evaluation result set of each factor based on the selection outcomes, which is the evaluation fuzzy matrix Ri = {r1, r1, …, rn}. Because the number of subjects for subjective factor evaluation varies, the fuzzy matrix Ri is formed as shown in Eq. (3.4) when the number of participating subjects is higher than or equal to one person;

$$R_i = \{r_1, r_2, \ldots, r_n,\}$$
$$\text{Which } r_i = \frac{u_i \text{ Evaluation Indicators} \times \text{ Select number of people}}{\text{Total number of evaluations}} \tag{3.4}$$

Step 4: The system administrator establishes the proportions of instructor and student evaluation as T and $1-T$, respectively;

Step 5: Compute the fuzzy comprehensive evaluation result B: Combining the evaluation fuzzy matrix and evaluation proportion with the teacher's evaluation result S, calculate the evaluation result from B as indicated in Eq. (3.5).

$$B = ST + R(1-T) \tag{3.5}$$

Step 6: Analyse and turn the evaluation result in B into the final score C, using the following Eq. (3.6).

$$C = BV \tag{3.6}$$

Note: Since the data in this article is carried out in units of each part of the course. As a consequence, the calculation yields the score for each component. When performing a comprehensive review, add the scores of each component and divide them by the total score. To acquire the students' final score, the fuzzy comprehensive assessment approach is utilized to synthesize each subjective indicator and mix it with the weight of each factor.

4 VERIFICATION OF MULTI-DIMENSIONAL ACHIEVEMENT EVALUATION SYSTEM

The system is tested using actual operating data after building a multi-dimensional evaluation mechanism. Consider a student's subject; the score incorporates a variety of activities as well as a subjective judgment of objective elements. Table 5 displays the objective factor statistics:

Factors	*Data*	*Standard volume*	*Score*
Video playback progress	*Video has been watched Duration 01:07:48*	*Total Video Duration 03:07:39*	*36.13*
Correctness rate of exercises	*Number of correct exercises 15*	*Total number of exercises 36*	*41.67*
Number of page visits	*75 times*	*50 times*	*100*
Discussion forum activity	*Participated in the discussion 26 times*	*30 times*	*86.67*

Table 5: Data table of objective factors.

Subjective factor data is mostly gathered through student self-assessment, group mutual evaluation, and teacher evaluation in after-class exercises. The data should count the number of choices made by teachers, students, and group members of various grades of each student component. Student evaluation data primarily contain students' self-evaluation and group mutual evaluation. Each subheading is utilized as a unit to assess the subjective factors in the full evaluation. The average score in the form of the total score is generated by computing the total score, which is the subjective factor score of the major. The following are the evaluation results based on the platform. There are a total of 16 sections, with a total of 6 student assessments for each section. As a result, the level of each subjective aspect in this course can be chosen 96 times. The subjective student evaluation factors are the objective student evaluation indicators, and the outcomes are as follows (Table 6).

Factors	Perfectly in line with	Conformity	General	Does not meet	Completely does not match
Basic theory mastery	92	2	2	0	0
Combining old and new knowledge	87	5	3	1	0
Basic Competence	85	9	2	0	0
Collaboration ability	85	8	1	2	0
Learning Method	93	1	1	1	0
Information Sharing	88	0	6	2	0
Exchange and Discussion	93	2	1	0	0
Self-discipline	92	4	0	0	0
Knowledge Digestion	90	0	4	2	0
Conscientiousness	92	2	1	1	0
Experience Degree	86	6	3	1	0
Sense of accomplishment	87	8	1	0	0

Table 6: Subjective factors student evaluation data table.

The teacher evaluation index is the same as the student evaluation index, however, it is displayed separately since the instructor evaluation is determined independently in the evaluation proportion. Because there is just one individual teacher, the subjective criteria are chosen 16 times. The amount of data picked from the actual evaluation is counted, as shown in Table 7, i.e., Teacher Evaluation Data.

Factors	Perfectly in line with	Conformity	General	Does not meet	Completely does not match
Basic theory mastery	13	2	1	0	0
Combining old and new knowledge	11	3	2	0	0
Basic Competence	14	1	1	0	0
Collaboration ability	8	5	3	0	0
Learning Method	13	2	1	0	0
Information Sharing	11	2	2	1	0
Exchange and Discussion	12	3	1	0	0
Self-discipline	7	6	2	1	0
Knowledge Digestion	10	3	3	0	0
Conscientiousness	12	2	2	0	0
Experience Degree	13	1	1	1	0
Sense of accomplishment	10	4	2	0	0

Table 7: Teacher evaluation data table of subjective factors.

The multi-dimensional performance evaluation method created in this study was tested using the above data, and a total score of 70.13 was obtained. The established multidimensional accomplishment evaluation system has been proven to be viable and correct.

5 CONCLUSION

The multidimensional achievement evaluation system can not only objectively and comprehensively evaluate each student's academic performance and learning process, but it can also allow each student to participate in the learning process more deeply, allowing students to improve in the process of actively participating in various exchanges and learning. Communication and linguistic abilities are required. This technology enables higher vocational colleges to make individualized adjustments based on the talent training plan, which may accurately and thoroughly depict the entire process and effect of students' learning. Most students are fully motivated to locate and solve challenges using this evaluation method. Students at various levels discover their deficiencies and current problems in various evaluations, which gives the conditions and conditions for accurately analyzing their learning and practicing abilities. The premise is to increase teaching quality.

Funding: This work was supported by Shandong Province Education science planning innovative literacy special project (Grant 2022CYB338).

Yan Mi, https://orcid.org/0000-0002-1407-6669
Bei Qiao, https://orcid.org/0000-0001-5740-4143

REFERENCES

[1] Cai, T.; Li, X.; Ding, X.: et al. Flood risk assessment based on hydrodynamic model and fuzzy comprehensive evaluation with GIS technique, International Journal of Disaster Risk Reduction, 35, 2019, 101077. https://doi.org/10.1016/j.ijdrr.2019.101077
[2] Cao, C.; Xie, Y.; Zhou, Y.: et al. Assessment of WeChat work online teaching modes under COVID-19: based on AHP and fuzzy comprehensive evaluation method, Open Journal of Social Sciences, 8(7), 2020, 349-358. https://doi.org/10.4236/jss.2020.87028
[3] Darko, A.; Chan, A. P. C.; Ameyaw, E. E.: et al. Review of application of analytic hierarchy process (AHP) in construction, International Journal of Construction Management, 19(5), 2019, 436-452. https://doi.org/10.1080/15623599.2018.1452098
[4] Guo, F. X.; Liu, Q. A.: study on the correlation between online learning behavior and learning effect—Based on the teaching practice of the flipped classroom of blackboard, Higher Education of Sciences, (01), 2018, 8-13.
[5] Lara, J. A.; Aljawarneh, S.; Pamplona, S.: Special issue on the current trends in E-learning Assessment, Journal of Computing in Higher Education, 32:1-8, 2020, https://doi.org/10.1007/s12528-019-09235-w
[6] Liu, H. J.; Love. P. E. D.; Ma, L.: et al. Predicting production-output performance within a complex business environment: from singular to multi-dimensional observations in evaluation, International Journal of Production Research, 59(24), 2021, 7390-7399.
[7] Mohammed, H. J.; Daham, H. A.: Analytic hierarchy process for evaluating flipped classroom learning. Computers, Materials & Continua, 66(3), 2021, 2229-2239. https://doi.org/10.32604/cmc.2021.014445
[8] Müller, C.; Mildenberger, T.: Facilitating flexible learning by replacing classroom time with an online learning environment: A systematic review of blended learning in higher education, Educational Research Review, 34, 2021, 100394. https://doi.org/10.1016/j.edurev.2021.100394
[9] Novgorodcev, A. R.; Jarquín-Laguna, A.: Multi-criteria analysis to rank offshore renewable technologies to support deep-water oil and gas production, Developments in Renewable Energies Offshore. CRC Press, 2020: 771-778. https://doi.org/10.1201/9781003134572-88

[10] Oguguo, B. C. E.; Nannim, F. A.; Agah, J. J.: et al. Effect of learning management system on Student's performance in educational measurement and evaluation, Education and Information Technologies, 26(2), 2021, 1471-1483. https://doi.org/10.1007/s10639-020-10318-w
[11] Qing, L. H.: Construction of quality evaluation system for translation majors in application-oriented colleges and universities, Journal of Literature and Art Studies, 5, 2019, 527-531.
[12] Rajabalee, Y. B.; Santally, M. I.: Learner satisfaction, engagement and performances in an online module: Implications for institutional e-learning policy, Education and Information Technologies, 26(3), 2021, 2623-2656. https://doi.org/10.1007/s10639-020-10375-1
[13] Sudirman, S.; Sarjan, M.; Rokhmat, J.: et al. Multidimensional Science Education on Performance Assessment Comprehensively with Collaborative Project Learning Based Model: Philosophy Perspective, Journal of Science and Science Education, 3(2), 2022, 96-102.
[14] Wang, M. Zhang, Z. Xu, M.: Postgraduate training performance evaluation applying weighting and comprehensive fuzzy evaluation methods, International Journal of Emerging Technologies in Learning, 16(1), 2021, 124-133. https://doi.org/10.3991/ijet.v16i01.18231
[15] Wang, X. H.; Wang, J. P.; Wen, F. J.: et al. Exploration and practice of blended teaching model based flipped classroom and SPOC in higher university, Journal of Education and Practice, 7(10), 2016, 99-104.
[16] Wong, J. K. W.; Oladinrin, O. T.; Ho, C. M. F: et al. Assessment of video-based e-learning in a construction measurement course, International Journal of Construction Management, 2018:1-7. https://doi.org/10.1080/15623599.2018.1435152