Research on the Construction of a Hybrid Teaching Evaluation System for Physical Education Courses in Universities

Haibin Wang[1,*], Ze Wang[2]

[1]School of Physical Education, Chizhou University, Chizhou, 247000, China
[2]School of Big Data and artificial intelligence, Chizhou University, Chizhou, 247000, China

*Corresponding author:0120100497@czu.edu.cn

Abstract. Under the strong impetus of "Internet plus", the reform and integration of online and offline hybrid teaching mode in colleges and universities are in full swing. In order to comprehensively evaluate the effectiveness of blended online and offline teaching in universities, 1059 valid data were collected through a questionnaire survey method, with 2021 students selected for the physical education club of Chizhou University as the research subjects. Using the hierarchical clustering Spearman correlation coefficient joint analysis method to construct a comprehensive evaluation index system for the effectiveness of the school's blended teaching classroom; And use the entropy weight method to assign weights to construct a TOPSIS comprehensive evaluation model, obtain the comprehensive scores of the respondents under this model, comprehensively evaluate the effectiveness of the club's blended teaching classroom, and provide relevant suggestions.

Keywords: Teaching reform; Online and offline; Spearman correlation; TOPSIS.

1 Introduction

In the context of the country's "deepening of physical education integration", the online teaching work of various universities has steadily promoted, providing a strong support for the exploration and practice of online and offline hybrid teaching models. The hybrid teaching mode breaks the study space limitations of traditional offline teaching models, better stimulates the interaction and enthusiasm of learning, and can get students' feedback from students in time. It is the main direction of the current curriculum reform of colleges and universities. Compared with traditional teaching, hybrid teaching is more diversified in evaluation systems for teaching effects. Whether students apply to this online and offline switching teaching model, how the school continues to promote hybrid teaching, and how to grasp the focus of hybrid teaching reform is the issue that the school must be considered in a mixed teaching model reform. Comprehensive evaluation of teaching effects adopting a hybrid teaching model

M. Yu et al. (eds.), *Proceedings of the 2024 5th International Conference on Big Data and Informatization Education (ICBDIE 2024)*, Advances in Intelligent Systems Research 182,
https://doi.org/10.2991/978-94-6463-417-4_29

is an important issue worth exploring. At present, the evaluation of classroom teaching effects is mostly based on the analysis of questionnaire statistics or a quantitative analysis of the data itself. For example, Meng Yueting and others [1] by quantitative analysis of the status of college sports courses, the collected body data was quantitatively analyzed, and the reasons for the changes in physical growth in the undergraduate learning stage of the student under the system were V -type. It is rare to build a comprehensive evaluation system for teaching effects based on data analysis.

In response to the above problems, this study takes the online and offline hybrid teaching model adopted by the Chizhou University Sports Club in the school teaching curriculum reform as a case, collects data through questionnaires, and uses hierarchical clustering and Spearman correlation coefficient to construct hybrid teaching. A comprehensive evaluation system for the impact of curriculum reform on college students' learning effects. And use confirmatory factor analysis to verify the rationality of the evaluation system. On its basis, the entropy weight-TOPSIS comprehensive evaluation model is constructed to provide reference opinions for the school to formulate curriculum reform plans and provide reference for subsequent curriculum reforms in other universities.

2 Preliminary work

2.1 Questionnaire design

Beginning in February 2020, Chizhou University Sports Club began to implement online teaching according to the curriculum reform plan, and tried to implement a hybrid online and offline teaching model. Online teaching has unique advantages over traditional offline teaching. In order to better promote education and teaching reform and improve teaching quality, the integration of online and offline hybrid teaching has become an important topic. In April 2021, the first and second grade students in the sports club were studied, and an investigation and research on the effectiveness of online and offline hybrid teaching in the sports club was organized, see Table 1. In terms of selecting the independent variables of the questionnaire questions, it is mainly set from four aspects. Internet usage time (Q2), learning methods (Q3), and campus platform usage (Q4) reflect students' own rigid conditions for using online and offline hybrid teaching. Q5-Q8 reflect students' evaluation and recognition of the new teaching model of online teaching. Q9-Q14 reflect students' subjective evaluation of the online and offline hybrid teaching model of physical education.

Table 1. Questionnaire question statistics table

Question	Indicators
What grade are you in?	Q1
How much time do you use the Internet every day?	Q2
How do you like to study?	Q3
Do you use the campus learning platform?	Q4
What is the online learning aspect of the sports club learning platform that	Q5

attracts you the most to online learning?	
Are you very confident and happy?	Q6
Are you willing to use online teaching courses?	Q7
Do you communicate with classmates and teachers online and cooperate with classmates to learn?	Q8
Where do you think the focus of offline classroom teaching should be placed?	Q9
Has online and offline hybrid learning brought you a lot?	Q10
Are you willing to accept the help of online and offline blended learning?	Q11
What do you think are the advantages of online and offline blended learning compared with traditional classroom teaching?	Q12
Online and offline blended teaching based on campus learning platforms can help you improve your learning efficiency and Learning quality?	Q13
Online and offline hybrid teaching based on the campus learning platform can enable you to actively complete learning tasks and broaden your learning?	Q14

2.2 Sampling design

This sampling design adopts two-stage sampling in the field of probability sampling, and its calculation formula is as formula (1):

$$\mathrm{n}_0 = \frac{nZP(1-P)}{\Delta_p^2 N + Z^2 P(1-P)} \tag{1}$$

Based on the actual number of students enrolled in Chizhou University, the total number is set to 16952, the confidence level is set to 95%, the error value, and the probability, and the minimum sample size is calculated as:

$$\mathrm{n}_0 = \frac{nZP(1-P)}{\Delta_p^2 N + Z^2 P(1-P)} = \frac{16952 \times 1.96^2 \times 0.5(1-0.5)}{0.05^2 \times 16952 + 1.96^2 \times 0.5(1-0.5)} = 488.49449$$

On the basis of determining that the design effect is 2.0, the obtained sample size after the design effect is:

$$x = n_0 \times deff = 976.98$$

When the effective response rate of the questionnaire is 80%, the sample size is:

$$n_1 = \frac{x}{0.8} = 1220$$

In this questionnaire survey, 1300 were released, and 1059 were effectively collected, meeting the requirements of sampling design.

3 Statistical analysis of the data

Statistical analysis was conducted on the 1059 pre-processed data. There were 739 students in the first grade, accounting for 69.7%; and 320 students in the second grade, accounting for 30.3%. It shows that first-year students are more positive and expectant than second-year students when facing the hybrid teaching reform. The statistics of students' daily use of the Internet are shown in Figure 1. There are 891 students who use the Internet for more than 2 hours a day, accounting for 84.14%, including 616 freshmen, accounting for 83.5%; and 275 sophomores, accounting for 86.2%; indicating the frequency of students' daily use of the Internet. Higher and lingering. Students who occasionally or frequently use campus network platforms account for the majority, with a total of 999 students, accounting for 94.33%. The specific statistics of the use of campus network platforms in first and second grade students are shown in Figure 2, which shows that the usage rate of school network platforms is relatively high. In terms of acceptance and opinions of hybrid teaching, among first grade students, 683 were able to accept online and offline hybrid teaching, while 56 were unwilling to accept it; among second grade students, 288 students accepted hybrid teaching, and 32 were unable to accept it.

Individuals and grades have different experiences on whether blended teaching can help and improve learning initiative, see Figures 3 and 4. Overall, 999 students, accounting for 94.33%, felt that blended teaching was helpful or very helpful to learning, and 980 students, accounting for 92.54%, felt that blended teaching was helpful or very helpful in improving learning initiative. Among them, 92.96% of first graders feel that blended teaching is helpful or very helpful in learning, and 97.5% of second graders; 92.02% of first graders feel that blended teaching is helpful in improving learning initiative, and 93.75% of second graders feel that blended teaching is helpful in improving learning initiative. Statistical analysis shows that college students are full of expectations for teaching reform and highly recognize the current hybrid teaching methods and teaching effects, indicating that hybrid teaching reform is not only driven by form, but also an inherent urgent need.

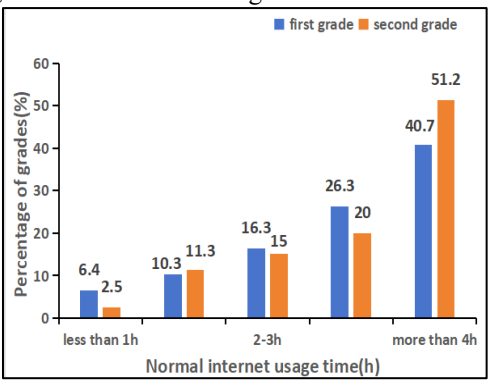

Fig. 1. Statistics chart of normal network usage time in grade one and grade two

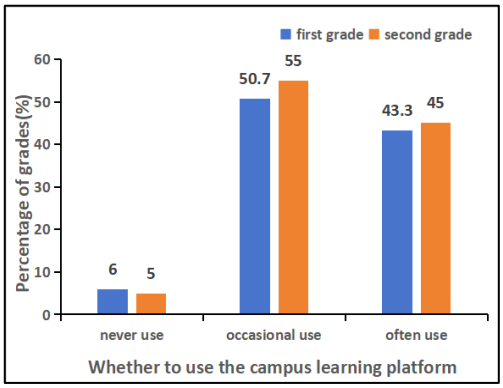

Fig. 2. Statistical chart of whether the campus learning platform is used in grade one and grade two

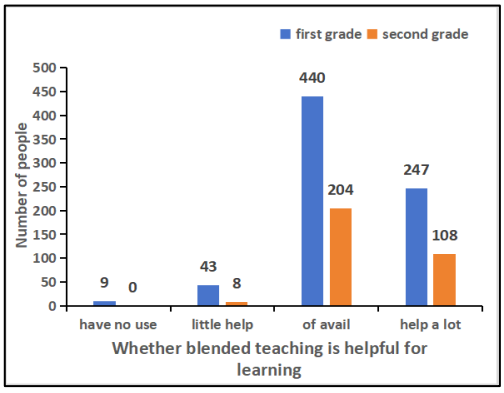

Fig. 3. Whether mixed teaching is helpful for learning statistical graph

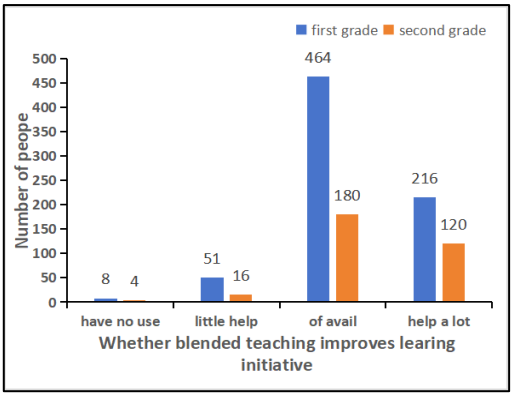

Fig. 4. Statistical graph of whether mixed teaching improves learning initiative

4 Establishment of the effect evaluation model of online and offline mixed teaching courses

4.1 Joint analysis of hierarchical clustering-Spearman correlation coefficient

Clustering algorithm is a simple data classification method, among which hierarchical clustering method is particularly famous. Hierarchical clustering is a hierarchical clustering method, and the final result is a tree structure. It calculates the minimum distance between two types of data points, combines the closest two types of data points, and iterates repeatedly until all data points are combined into one class to generate a cluster pedigree [2].

The Jacques-Bela test was used to test the 14 characteristic indicators of the preprocessed questionnaire data. The p-values corresponding to each feature are less than 0.05, indicating that the random variable does not obey the normal distribution and deviates far, rejecting the null hypothesis. Therefore, statistical methods that require normal distribution, such as Pearson correlation coefficient and variance analysis, cannot be used [3]. This article uses the Spearman correlation coefficient method for research. The Spearman correlation coefficient method is a method commonly used to evaluate the monotonic relationship between two variables [4]. Its advantage is that it does not need to meet constraints such as continuous data, normal distribution, and linear relationships. The calculation formula (where: ρ is the correlation coefficient, n is the sample size,$d_i$is times) is as formula (2):

$$\rho = 1 - \frac{6\sum d_i^2}{n\left(n^2 - 1\right)} \tag{2}$$

Before constructing the online and offline hybrid teaching effect evaluation index system, the evaluation indicators were selected, and 11 quantitative questions related to the online and offline hybrid teaching of sports (questions 3, 4, and 6-14 respectively) were selected as the next step of clustering indicator data. After Z-Score standardization of the data using SPSS Statistics 25 software, Euclidean distance was selected for inter-group linkage clustering, and the Spearman correlation coefficient of each indicator was combined for joint analysis. The results are shown in Figure 5 and Figure 6:

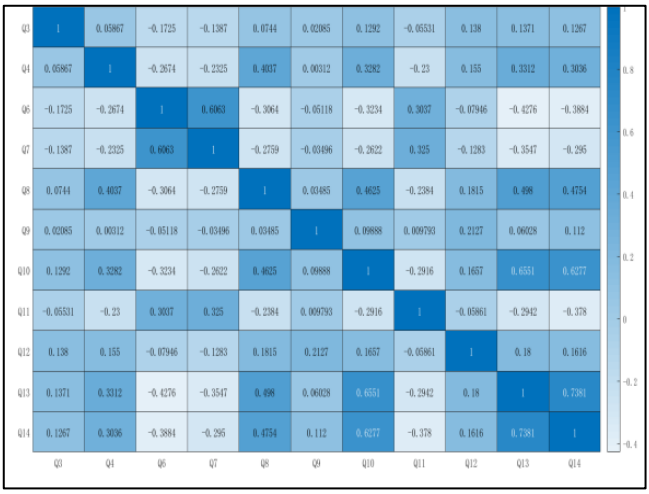

Fig. 5. Heat map of Spearman correlation coefficient

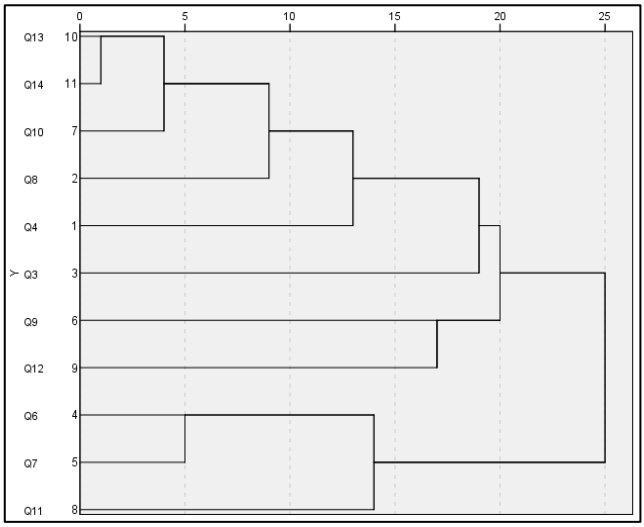

Fig. 6. For the hierarchical clustering of the pedigree plots

By observing the Spearman correlation coefficient heat map, it can be seen that the correlation between questions 8-14 is stronger and more concentrated than the correlation of other question indicators. Therefore, in the hierarchical selection of clustering, questions 8-14 can be prioritized and classified as A sub-layer of a class. By observing the above pedigree diagram, questions 3, 4, 8, 10, 13, and 14 are divided into one layer, questions 9 and 12 are divided into one layer, and questions 6, 7, and 11 are divided into one layer and co-clustered into three layers, see Table 2 shows:

Table 2. Evaluation system table of physical education mixed teaching effect

Comprehensive evaluation system for the impact of sports online and offline hybrid teaching models on college students' learning	Advantages of blended teaching	Do you use the campus learning platform?
		Do you communicate with classmates and teachers online, and do cooperative learning with classmates?
		Does online and offline blended learning bring you great help?
		Online and offline blended teaching based on the campus learning platform can Help you improve learning efficiency and quality.
		Online and offline hybrid teaching based on the campus learning platform can enable you to actively complete learning tasks and broaden your learning.
		What do you think are the advantages of online and offline hybrid learning compared with traditional classroom teaching?
	Classroom teaching focus	Where do you think the focus of classroom teaching should be?
		What do you think are the advantages of online and offline blended learning compared with traditional classroom teaching?
	Feasibility of online teaching	Are you very confident and happy about learning online?
		Are you willing to use online teaching?
		Are you willing to accept online and offline blended learning methods for your courses?

4.2 Validity analysis -confirmatory factor analysis

In order to verify whether the above-mentioned evaluation index system based on hierarchical clustering-Spearman correlation coefficient is reasonable, the criterion layer (second layer) index of the system is used as a factor and a confirmatory factor analysis model is constructed to test the relationship between the theoretical model and fit to actual data. This is used to verify whether the factors formed by the scheme layer (each latent variable in the third layer) are effective [5].

In this model, the "advantages of online and offline hybrid physical education teaching" (i.e.questions 3, 4, 8, 10, 13, and 14) in the evaluation index system constructed above are taken as factor 1; "the focus of classroom teaching" (i.e.questions 9 and 12) as factor 2; "Online teaching feasibility" (i.e. questions 6, 7, 11) as factor 3; SPSSPRO statistical analysis software was used to conduct confirmatory factor analysis, and the obtained factor loading coefficients are shown in Table 3:

Table 3. Factor load coefficient table

Factor	variable	Non-standard coefficient	loadStandardized coefficient	load z	S.E.	P
Factor1	Q13	1	0.887	-	-	-
	Q14	1.146	0.824	32.137	0.036	0.000***
	Q10	0.821	0.757	28.607	0.029	0.000***
	Q8	0.63	0.599	20.837	0.03	0.000***
	Q4	0.456	0.419	13.652	0.033	0.000***
Factor2	Q9	1	0.309	-	-	-
	Q12	1.34	0.552	1.402	0.956	0.161
Factor3	Q6	1	0.783	-	-	-
	Q7	0.826	0.739	18.403	0.045	0.000***
	Q11	0.396	0.464	13.081	0.03	0.000***

Observing Table 3, we can see that most of the internal measurement variables in the three constructed factors passed the significance test (P<0.05), and the standardized loading coefficient values were all greater than 0.6 except for questions 4, 9, 11 and 12. The standardized loading coefficients of these four questions also tend to be 0.6 to a great extent, indicating that the measured variables meet the factor requirements and have sufficient variance contribution to the explanation rate.

Table 4. Statistical table of fitting indicators of validation type factor analysis models

Commonly used indicators	X^2	df	P	Chi-square degrees of freedom ratio	GFI	RMSEA	RMR	CFI	NFI	NNFI
price criterion for judgement	-	-	>0.05	<3	>0.9	<0.10	<0.05	>0.9	>0.9	>0.9
price criterion for judgement	241.734	32	0	7.554	0.928	0.079	0.014	0.936	0.928	0.911

At the same time, it can be seen from Table 4 that the $X^2$of the model is 241.734, the GFI (Goodness of Fit Index), CFI (Comparative Fit Index), and NNFI (Non-normed Fitting Coefficient) are 0.928, 0.936, and 0.911 respectively, all greater than 0.9, and the RMSE (Root Mean Square Error of Approximation) is less than 0.1 etc. The above indicators all show that the model has a better fitting effect, thus obtaining the results of the model for the evaluation index system constructed above. See Table 5:

Table 5. Evaluation results of the validation-type factor analysis model

Factor	Mean variance-extracted AVE values	Combined reliability CR value
Factor1	0.539	0.842
Factor2	0.171	0.288
Factor3	0.51	0.737

Table 5 shows the model AVE and CR index structures. According to the average common factor variance extraction amount AVE and combined reliability CR structure can be used to represent the convergent validity of variables within factors. Observing

the above table, we can see that the aggregation effect of factor 1 and factor 3 is more significant.

4.3 Construct the comprehensive evaluation model (Entropy Right-TOPSIS Model)

A comprehensive evaluation model is established based on the comprehensive evaluation system of online and offline hybrid teaching effects of sports clubs. The TOPSIS evaluation model based on entropy weight assignment is selected here, which not only avoids the subjectivity of weight selection, but also makes full use of its advantage of not having too many requirements on sample data [6].

The entropy weight method is an objective weighting method. Its principle is that when the variation degree of an indicator is smaller, the amount of information reflected is also smaller, and its corresponding weight should be lower [7]. The solution steps are as follows [8-9]:

Step 1: Calculate the probability matrix based on the normalized matrix, and use the proportion of the th sample under the th indicator as the probability. Each element in the probability matrix is as formula (3):

$$Z = \begin{pmatrix} \tilde{z}_{11} & \cdots & \tilde{z}_{1m} \\ \vdots & \ddots & \vdots \\ \tilde{z}_{n1} & \cdots & \tilde{z}_{nm} \end{pmatrix}, \qquad P_{ij} = \frac{\tilde{z}_{ij}}{\sum_{i=1}^{n} \tilde{z}_{ij}} \tag{3}$$

Step 2: The information entropy of each indicator needs to be calculated. For the th indicator, the information entropy calculation formula is as formula (4):

$$e_j = -\frac{1}{\ln n} \sum_{i=1}^{n} \left[p_{ij} \cdot \ln\left(p_{ij} \right) \right], \quad j = 1, 2, \ldots, m \tag{4}$$

Step 3: Since the greater the information entropy, the smaller the amount of existing information, then the information utility value is defined as formula (5):

$$d_j = 1 - e_j \tag{5}$$

Step 4: Normalize the information utility value to obtain the entropy weight of each indicator as formula (6):

$$W_j = \frac{d_j}{\sum_{i=1}^{m} d_j}, \quad j = 1, 2, \ldots, m \tag{6}$$

Calculate the entropy weight (Indicator Weight) of questions 3, 4, and 6-14, see Table 6.

Table 6. Statistical table of entropy weight method

Entropy Weight Method			
index	Information entropy value e	Information utility value d	weight (%)
Q14	0.988	0.012	1.197
Q4	0.983	0.017	1.747
Q13	0.994	0.006	0.649
Q11	0.644	0.356	36.663
Q10	0.995	0.005	0.566
Q8	0.984	0.016	1.625
Q7	0.733	0.267	27.531
Q6	0.783	0.217	22.425
Q3	0.969	0.031	3.22
Q9	0.977	0.023	2.423
Q12	0.981	0.019	1.953

The TOPSIS method (Distance between Superior and Inferior Solutions) is a widely used comprehensive evaluation method. It can make full use of the information of the original data and calculate the Euclidean gap between each scheme more accurately[10-11]. This article will use the entropy weight obtained above as the custom weight of the TOPSIS method, combined with the above 11 groups of online and offline hybrid teaching performance indicators that affect college students' learning, calculate the positive and negative ideal solutions for each respondent, and calculate it is scored.

Treat the obtained non-dominated solution set as a data set, calculate the distance between each non-dominated solution and the positive and negative ideal solutions, and select the 20 solutions with the smallest distance as the positive and negative ideal solution sets respectively. Conduct descriptive statistical analysis on the positive and negative ideal solution sets, and use statistical quantities to calculate the scoring intervals. The final results are shown in Table 7.

Table 7. Entropy weight-the top 20 results of TOPSIS ranking

index	Positive ideal solution distance(D+)	Negative ideal distance(D-)	Comprehensive score index	reorder
144	0.166097946	0.954312017	0.851752526	1
407	0.166097946	0.954312017	0.851752526	1
671	0.166097946	0.954312017	0.851752526	1
939	0.166097946	0.954312017	0.851752526	1
219	0.174014986	0.952900172	0.845582886	2
482	0.174014986	0.952900172	0.845582886	2
748	0.174014986	0.952900172	0.845582886	2
1016	0.174014986	0.952900172	0.845582886	2
178	0.195759806	0.94867173	0.828945813	3

441	0.195759806	0.94867173	0.828945813	3
706	0.195759806	0.94867173	0.828945813	3
974	0.195759806	0.94867173	0.828945813	3
364	0.226763391	0.946367515	0.806702398	4
628	0.226763391	0.946367515	0.806702398	4
895	0.226763391	0.946367515	0.806702398	4
213	0.227628966	0.9472338	0.806250592	5
476	0.227628966	0.9472338	0.806250592	5
742	0.227628966	0.9472338	0.806250592	5
1010	0.227628966	0.9472338	0.806250592	5
44	0.232813836	0.955199348	0.804030932	6

5 Results analysis

This article uses the TOPSIS model based on entropy weight assignment to conduct a comprehensive evaluation of the online and offline hybrid teaching of Chizhou University Sports Club. Compared with most existing physical education teaching evaluation studies, the results of this model are more specific, obtaining comprehensive scores from different interviewees. However, this model also has certain limitations. For example, the entropy weight method has higher standardization requirements for indicator data. The next step can be to consider using the analytic hierarchy process and the entropy weight method to assign values. In terms of comprehensive evaluation models, the rank sum ratio method (RSR) and the TOPSIS method and RSR fuzzy joint evaluation method can also be considered for comprehensive evaluation. The following are the conclusions and corresponding countermeasures based on the analysis of the final results.

5.1 Lower grade students have a more positive attitude towards mixed teaching and are full of expectations for mixed teaching

According to the statistical analysis results after preprocessing of the questionnaire data, it can be seen that first-year students use online platforms longer than second-year students, and the number of students who have a positive attitude towards online teaching and blended teaching is higher than that of second-year students. grade. As first-year college students who have just entered university, they have no inherent knowledge of all aspects of university course teaching, and are more suitable for quickly switching to the hybrid teaching model. Among the interviewees, most of them prefer the teaching model of online teachers teaching and offline self-study, are full of expectations for teaching reform, and highly approve of the current hybrid teaching method and teaching effect, indicating that the hybrid teaching reform is

both a form and a Drive is an inner urgent need. To a certain extent, it shows that blended teaching has certain feasibility.

5.2 Establish a comprehensive evaluation system for the effectiveness of mixed online and offline teaching for college students

Based on the results of the co -analysis of the layer -Spearman correlation coefficient, establish a comprehensive evaluation system for college students' sports online and offline hybrid teaching classroom effects, and use verification factor model for validity analysis. The 11 indicators (excluding quantitative indicators) are divided into three factors: "Sports online and offline hybrid teaching advantages", "key priorities of classroom teaching", and "online teaching feasibility". The use of these three factors is reflected in the influence of online and offline hybrid classroom teaching models adopted by the Sports Club of Chizhou University. The online and offline hybrid teaching adopted by sports clubs should consider the advantages of sports online and offline hybrid teaching, key classroom teaching, and online teaching feasibility. In the implementation of a hybrid teaching mode, teachers must take into account whether students have the conditions for online teaching and whether the content of the curriculum is suitable for online teaching. In addition, while exerting the advantages of Internet online teaching, we must also pay attention to the advantages of offline teaching. As a course that improves students' physical fitness, offline courses are essential. Offline classrooms can improve students' enthusiasm for class and exercise the comprehensive quality of students.

5.3 Optimize the mixed teaching curriculum setting, and strengthen the scientific guidance and supervision of the use of the network platform

The TOPSIS method assigned by the entropy right method comprehensively evaluates the 1059 sample data collected. Statistics selected the first 20 scores for results for statistics and found that all of them are first grade students. It is more explained that the first grade students' attitude towards online and offline hybrid teaching models is more positive, and they are more willing to try to experience hybrid teaching models. Although the second grade is satisfied with the effect of hybrid teaching model Grade students have low sensitivity to new things, and their willingness to change is not strong. The situation of students in the second grade can be used to optimize the teaching curriculum settings, change the content of curriculum teaching, and increase the reform of learning participation and experience. Most of the students' study time is greater than 2 hours. In response to this, we need to pay more attention to the setting of the content of the line course, and actively integrate the hotspots, scientific and practical and curriculum ideological and political parts that college students pay attention to. Students with short online learning time participate in class activities combining offline and online. At the same time, it is also necessary to transfer the attention of the students' nostalgia for the network.

6 Conclusions

This study aims to comprehensively evaluate the teaching effect of online and offline hybrid courses in college sports. It collects samples from students of the the physical education club of Chizhou University through questionnaires. Using this data set, a comprehensive evaluation index system for the school's blended teaching classroom effects was constructed through hierarchical clustering-Spearman correlation coefficient joint analysis method. And the entropy weight method is used to assign weights to construct the TOPSIS comprehensive evaluation model to obtain the scores of the interviewed objects. Through a systematic analysis of the actual scores of each object, combined with grades and learning conditions, corresponding suggestions are provided for the subsequent reform of the school's physical education curriculum. Applying this comprehensive evaluation system to the comprehensive evaluation research on the teaching effect of online and offline hybrid courses in colleges and universities can help managers further improve teaching plans and has certain practical application value.

Fund Project

Provincial Key Research Project of Quality Engineering Teaching in Higher Education institutions of Anhui Province (2021jyxm1012); Scientific Research Project of Anhui Provincial Department of Education (SK2021A0738).

Reference

1. Meng Yueting, Ma Wenjun. Research on the reform and implementation of quality education in colleges and universities [J]. Journal of Xi'an Institute of Physical Education, 2002 (S1): 213-215.
2. Liu Jiaxi. Research on dynamic error source tracing method of five-axis CNC machine tools based on hierarchical clustering analysis[D]. University of Electronic Science and Technology of China, 2019.
3. Liu Zijun. The preferred method of repeated cracking wells based on the low-lying sandstone storage based on the pearson correlation coefficient [J]. Oil and gas geology and harvesting, 2022,29 (02): 140-144.
4. Li Yuan, Liu Yutian, Feng Liwei. Feature extraction and fault detection of nonlinear dynamic processes based on Spearman correlation analysis [J]. Journal of Shandong University of Science and Technology (Natural Science Edition), 2023, 42 (02): 98-107.
5. Song Xiaoyan, Zeng Yan, Liu Ganhong. Research on the construction of online learning power models before the job-Analysis of exploration and verification factor analysis [J]. Journal of Liupanshui Normal University, 2023,35(01): 67-77.
6. Zhang Jing, Zhang Zhizhi, Li Xiaodong, Sun Qi, Qiao Wei. The TOPSIS method based on entropy rights is evaluated by the port military transportation capacity [J]. Tsinghua University Journal (Natural Science Edition), 2018,58(05): 494-499.

7. Xiao Yan, Wang Peng, Chen Guosheng. Research on the provincial competitiveness evaluation of the Yangtze River Economic Belt based on the TOPSIS method and factors of regional differences [J/OL]. Economic Geography: 1-10.
8. KIMA R.A Study on Competitiveness Analysis of Ports in KOREA and China by Entropy Weight Topsis [J]. The Asian Journal of Shipping and Logistics.2016,32(4): 187-194.
9. NADABANS, DZITACS, DZITACI.Fuzzy TOPSIS:A general view[J]. Procedia Compute r Science.2016,91: 823-831.
10. Yang Jingwen, He Gang, Zhou Qingting, etc. Evaluation of ecological safety in Anhui Province based on DPSIR-TOPSIS model [J]. Journal of Anhui Agricultural University (Social Science Edition), 2019,28(5): 41-48.
11. Meng Dinghua, Zhu Shijie, Mao Jinqiao. Poyang Lake Water Environment Evaluation Research based on the TOPSIS method [J]. Hydropower energy science,2023,41(03): 44-47.