Pak. j. life soc. Sci. (2024), 22(2): 8470-8486 E-ISSN: 2221-7630;P-ISSN: 1727-4915

Pakistan Journal of Life and Social Sciences

www.pjlss.edu.pk

https://doi.org/10.57239/PJLSS-2024-22.2.00639

RESEARCH ARTICLE

Application of Diversified Teaching Strategies in University Physical Education Courses

Ruiyan Wang[1], Ganbat Danaa[1*]

[1,2]Center for Open Education, Mongolian University of Science and Technology, Ulaanbaatar, Ulaanbaatar, Mongolia

[1]Sports academy, Shijiazhuang University, Shijiazhuang, Hebei, China

ARTICLE INFO

Received: Jul 14, 2024

Accepted: Sep 23, 2024

Keywords

Diversified Teaching Strategies

University Physical Education Courses

Students' Participation Willingness

Course Grades

Course Satisfaction

***Corresponding Author:**

ganbatda@must.edu.mn

ABSTRACT

In the modern higher education system, university physical education courses play an important role in cultivating students' comprehensive development, not only promoting physical health, but also helping to cultivate teamwork and leadership. However, traditional teaching models are often limited by single methods, neglect of individual differences among students, and incomplete evaluation methods, which weaken students' learning experience and course effectiveness. To explore these issues in depth and propose effective solutions, this article obtains data through multiple channels, including designing detailed questionnaire surveys to collect students' opinions and feedback on current teaching methods, teaching resources, personalized teaching strategies, and classroom interactions, while utilizing course grades data recorded in the academic system. This article uses two quantitative analysis methods, structural equation modeling (SEM) and multiple linear regression analysis, to empirically analyze the application effect of diversified teaching strategies in university physical education courses. SEM is used to reveal complex relationships between multiple latent variables, and multiple linear regression analysis is used to evaluate the specific relationship between the use of specific teaching resources and student course grades. The research results indicate that the implementation of diversified teaching strategies significantly improves students' participation willingness, course grades, and satisfaction, with course grades increasing from 75.4 points to 85.7 points, participation willingness increasing from 3.2 to 4.5, and course satisfaction increasing from 3.5 to 4.4. These findings not only validate the effectiveness of diversified teaching strategies in improving the teaching effectiveness of university physical education courses, but also provide scientific basis for the teaching reform of university physical education courses, promoting the optimization of teaching strategies and thereby enhancing students' learning experience and course effectiveness.

INTRODUCTION

In the modern higher education system, university physical education courses not only provide students with physical exercise, but also is important in cultivating their comprehensive development. However, with the continuous evolution of teaching modes, many university physical education courses still use traditional teaching methods, which often focus on lectures and have a relatively single training mode, failing to fully meet the individual requirements of students. The limitations of this traditional model are manifested in the monotony of teaching content, single teaching methods, and insufficient student participation, which not only affect students' classroom experience but also have a negative impact on their academic performance and course satisfaction. (Demchenko, et al. 2021; Varea, et al. 2022). The traditional physical education teaching model relies on standardized training and repetitive exercises, which can ensure teaching consistency but ignore individual differences and participation motivation of students. Research shows that this single model may weaken students' interest and participation in learning and thus affect their learning results. To address this issue, the education sector is gradually recognizing the necessity of diversified teaching strategies. This type of strategy can not only enrich teaching content, but also effectively stimulate students' interest in learning and enthusiasm for participation. O'Neill, and Padden (2021).

The purpose of this article is to explore the application effect of diversified teaching strategies in university physical education courses, with a focus on analyzing the impact of these strategies on students' participation willingness, course grades, and satisfaction. Specifically, this article examines the following aspects: whether multiple teaching methods (such as lectures, practices, and discussions) can significantly enhance participation willingness; whether diversified teaching resources (such as videos, textbooks, and physical models) effectively improve course grades; whether personalized teaching strategy (adjustments based on physical abilities) improve student performance; whether interactive activities (such as group cooperation and competitions) improve course satisfaction. Therefore, this article proposes the following four main hypotheses: hypothesis 1 - adopting multiple teaching methods can significantly enhance students' participation willingness; hypothesis 2 - combining diversified teaching resources can effectively improve students' course grades; hypothesis 3 - implementing personalized teaching strategies can significantly improve students' performance; hypothesis 4 - incorporating highly interactive activities has a significant impact on improving students' course satisfaction.

These hypotheses provide a theoretical basis for the empirical research in this article and guide subsequent research methods and data analysis. By validating these hypotheses, this article hopes to provide scientific basis for the teaching reform of physical education courses in universities, promote the optimization of teaching strategies, and thereby enhance students' learning experience and course effectiveness.

2 RELATED WORK

In recent years, diversified teaching strategies have received much attention in the field of education. By combining various teaching methods, resources, and tools, these strategies aim to enhance students' interest and participation in learning, and based on constructivism, emphasize students' active construction of the learning process. Diversified teaching methods can effectively promote deep learning. Pasira, (2022) In practical applications, the combination of lectures, practices, and discussions can better meet the needs of different students, enhance learning motivation and participation. (Gil-Arias et al. 2021). However, university physical education still faces challenges from traditional models, relying too much on standardized training and skill exercises, with a single course content that is difficult to fully stimulate students' interest. Moustakas and Robrade. (2022). In addition, this teaching model may also overlook individual differences among students, resulting in some students being unable to receive learning support that is suitable for themselves, further affecting the overall effectiveness of the course. (Calderón et al. 2021). Therefore, many researchers suggest that diversified teaching strategies needs to be applied in university physical education teaching to address the limitations of the current teaching model. (Tremblay et al. 2021; Wang et al. 2021).

In this context, research has explored the application results of diversified teaching strategies in physical education teaching. It has been found that integrating different teaching resources and methods into physical education courses can significantly enhance students' participation willingness and course satisfaction. For example, combining diversified teaching resources such as videos and physical models can not only enrich the course content, but also help students better understand and master motor skills. Gheyssens et al. (2022). Additionally, personalized teaching strategies have been proven to effectively improve students' learning outcomes. By adjusting according to students' physical abilities, the strategies can meet the needs of different students and enhance their overall performance. Block et al. (2021). In empirical research, structural equation modeling (SEM) and regression analysis are commonly used analytical tools. The SEM model is suitable for analyzing complex relationships between multiple variables and can reveal the direct and indirect effects of diversified teaching strategies on students' participation willingness and grades. Ati and Celik. (2021). It can be used to examine the comprehensive impact of variables such as teaching methods, resource utilization, and teaching interaction on students' learning outcomes. The regression analysis is used to evaluate the specific contribution of diversified teaching resources to student performance, and it can help researchers determine the significant impact of each teaching resource on student performance. Khan and Ghosh. (2021). The combination of these two methods provides strong empirical support for the research of diversified teaching strategies. Existing literature has provided rich theoretical and empirical evidence for the application of diversified teaching strategies in university physical education courses, revealing the shortcomings of existing teaching models and providing a scientific basis for improving strategies. On this basis, this article further explores and verifies the specific effects of diversified teaching strategies.

3 Design and Methods

This article adopts empirical research methods to explore the application effect of diversified teaching strategies in university physical education courses, especially their impact on students' participation willingness, course grades, and course satisfaction. Based on literature analysis and theoretical foundation, this article verifies the effectiveness of diversified teaching strategies in practical teaching through structural equation modeling and multiple linear regression analysis.

(1)Design framework

The core framework of this article is based on the theory of diversified teaching strategies, aiming to reveal the multidimensional impact of different teaching methods, teaching resources, and interactive activities on students' learning experience. The research design is carried out through the following main steps: firstly, clarifying the independent and dependent variables in the study, and clarifying the potential relationships between each variable; secondly, constructing a conceptual model, and designing empirical analysis steps; finally, verifying the effectiveness of diversified teaching strategies in improving students' participation willingness, course grades, and satisfaction through SEM and multiple linear regression methods. This research framework provides systematic guidance for data collection and analysis.

(2)Variable definition

In this article, the main independent variables (IV) include four aspects: teaching methods, teaching resources, personalized teaching strategies, and interactive activities. Specifically, teaching methods involve lectures, practices, and discussions; teaching resources include videos, textbooks, physical models, etc; personalized teaching strategies refer to adjusting teaching based on students' physical abilities; interactive activities include group cooperation and competitions to enhance classroom interaction. The dependent variable (DV) includes students' participation willingness, course grades, and course satisfaction, which respectively reflect students' level of classroom participation, academic performance, and overall learning experience. (Leng and Shao, 2022; Raiola, 2023).

Through clear variable definitions and classifications, this article is able to systematically and objectively measure the impact of different aspects of diversified teaching strategies on students. Each independent and dependent variable is quantified through questionnaire surveys and performance data to ensure the accuracy and consistency of subsequent analysis.

(3)Data analysis methods

To verify the research hypotheses, this article adopts two data analysis methods: SEM and multiple linear regression analysis. Firstly, SEM is used to explore the relationship between latent variables (LV) and observed variables (OV), (Hernando et al. 2021; Fu and Jiang, 2024) and it can simultaneously process multiple variables and clarify causal relationships between factors through path analysis. Comparative Fit Index (CFI), Ximenez et al. (2022). Root Mean Square Error of Approximation (RMSEA), Shi et al. (2022). Tucker-Lewis Index (TLI), Montoya and Edwards. (2021) and Normed Fit Index (NFI) are used as goodness-of-fit indexes to evaluate the model's adaptability. (Sathyanarayana and Mohanasundaram, 2024)

In addition, multiple linear regression analysis is used to further examine the impact of the use of teaching resources on students' course grades. Through regression modeling, the linear relationship between the independent variable of teaching resources and the dependent variable of student performance is clarified, and other variables that may affect the results are controlled. The significance test of regression coefficients, R^2 value, and residual analysis are used to evaluate the predictive and explanatory power of the regression model.

By combining the results of SEM and regression analysis, this article can gain a deeper understanding of how diversified teaching strategies affect student performance in university physical education courses and can provide reliable empirical evidence for practical teaching..

(1) Data sources

The data in this article mainly comes from the physical education courses of a comprehensive university in China. This university has rich physical education courses and diverse student population, providing representative sample data. The physical education courses in this article include multiple projects, covering students of different grades and majors to ensure the breadth and representativeness of the data.

(2) Sample selection criteria

This article takes undergraduate students in university physical education courses as samples, covering various courses such as basketball, badminton, and swimming to ensure data diversity and representativeness. A total of 500 students from freshman to junior year are selected as the samples, reflecting the learning stages of different grades. Gender, grade level, and course distribution are detailed in Figure 1(a), (b), and (c):

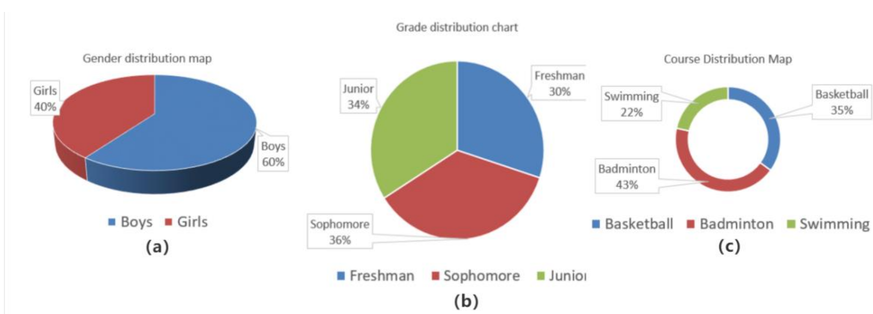

Figure 1. Distribution of sample data

This arrangement aims to comprehensively and evenly reflect the performance of students in university physical education courses and their response to diversified teaching strategies.

(3) Privacy protection statement

In the process of data collection and processing, the research in this article strictly complies with relevant privacy protection laws and regulations. All participants' personal information is strictly confidential and used only for research purposes. The data is recorded and stored anonymously to ensure that the privacy of participants is not violated. The use and analysis of the research data in this article are limited to academic research, and any personal information of participants is not disclosed to any third party.

3.1 Survey Questionnaire Design

To evaluate the application effect of diversified teaching strategies in university physical education courses, this article designs a comprehensive questionnaire, focusing on the following main dimensions: teaching methods, teaching resources, interactive activities, and personalized teaching.

The satisfaction and participation of students in different teaching methods such as lectures, practices, and discussions are evaluated through a questionnaire survey, using the Likert five-point scale (1 represents very dissatisfied, and 5 represents very satisfied). The evaluation of teaching resources focuses on the effectiveness of using videos, textbooks, and physical models, and the Likert five-point scale is also used to quantify student feedback. In the interactive activity section, feedback from students on their participation and satisfaction with group cooperation and classroom competitions is collected. In the personalized teaching section, the impact of teachers' teaching strategies tailored to individual needs on students' learning outcomes is evaluated, helping to understand how interactive activities and personalized teaching strategies promote students' learning motivation and improve course satisfaction.

The questionnaire design undergoes rigorous pre-testing, and its reliability is validated through Cronbach's alpha coefficient to ensure internal consistency of the questionnaire. (Sijtsma and Pfadt, 2021). Meanwhile, the questionnaire content is reviewed by educational experts to ensure the effectiveness and reliability of the measurement tool. The questionnaire is distributed through the online platform named Wenjuanxing and offline classroom paper questionnaires to ensure the representativeness of the sample and the validity of the data. During the questionnaire distribution and collection process, it is ensured that students voluntarily participate, and detailed instructions and contact information are provided to answer students' questions and address any potential issues. Please refer to Appendix 1 for detailed questionnaire content.

3.2 Course Grades Data

The course grades data covers indicators such as final exam scores, motor skills test scores, and classroom performance, which are recorded and summarized by the subject teacher according to standardized rating rules. The final exam scores reflect students' mastery of theoretical and practical skills, and classroom performance includes students' cooperation ability, group activity performance, and individual project completion quality. All data is integrated into the database for subsequent statistical analysis. Privacy protection principles are strictly adhered to during data collection and integration, ensuring accuracy and confidentiality.

3.3 Data Preprocessing

In this article, data preprocessing is a crucial step in ensuring data quality and reliability. By preprocessing questionnaire data and course grades, noise, outliers, and incomplete data are removed to ensure the accuracy of model construction and analysis. The main preprocessing steps include missing value processing, outlier detection, data standardization, categorical variable encoding, and data transformation.

(1) Missing value handling

In this article, there are issues with incomplete questionnaire filling or incomplete recording during the data collection process. For missing data, this article adopts the following processing strategy: removing samples with a missing rate exceeding 30% to ensure data integrity. For variables with low missing rates, metric variables are filled in using the mean imputation method, while categorical variables are filled in using the mode imputation method. These methods aim to maintain data integrity and avoid the impact of improper handling of missing values on model results.

Assuming $X_{i,j}$ is the j-th variable of the i-th sample, if the missing proportion in sample X_j is low, the mean imputation can be performed using the following formula:

$$X_{i,j} = \frac{1}{n}\sum_{i=1}^{n} X_{i,j} \qquad (1)$$

(2) Outlier detection and handling

In the dataset, there may be certain outliers, which are samples that deviate significantly from other observed values. This article uses the Z-score method to identify outliers. (Merza and Mohammed, 2021). The Z-score for each sample's data is calculated, defined as:

$$Z_{i,j} = \frac{X_{i,j}-\mu_j}{\sigma_j} \qquad (2)$$

Among them, $X_{i,j}$ is the j-th observed value of the i-th sample, and μ_j and σ_j are the mean and standard deviation of sample X_j, respectively. If $|Z_{i,j}|>3$, the observed value is considered an outlier. When dealing with outliers, data with extreme anomalies and no research significance is directly excluded, while extreme data that may have certain explanatory significance is retained.

(3) Data conversion

In some cases, the data may not follow a normal distribution, which can lead to bias in the analysis results in multiple linear regression models and SEM models. Therefore, for data that does not conform to a normal distribution, this article uses the log transformation method for processing. (West, 2022; Sun and Xia, 2024). For normally skewed data, taking the natural logarithm can make the data distribution more symmetrical. The conversion formula is as follows:

$$X'_{i,j} = \log(X_{i,j} + 1) \qquad (3)$$

Through data conversion, the influence of skewed distribution is eliminated to ensure that the data better meets the assumptions of the model, thereby improving the applicability and stability of the model.

(4) Classification variable encoding

For the categorical variables in this article (such as gender, grade, etc.), the dummy variable encoding method is used to convert them into metric variables. (Dahouda and Joe, 2021; Halvorson, et al. 2022). Specifically, for variables with k categories (such as grade: freshman, sophomore, junior), the variables are converted into k-1 binary variables to indicate whether it belongs to a specific category.

(5) Dataset partitioning

To ensure the robustness of the model, the dataset is divided into a training set and a testing set. The training set is used to constructing the model, and the testing set is used to evaluate the predictive performance of the model. The partitioning ratio is 7:3 between the training set and the testing set.

3.4 Model and Algorithm

Structural equation modeling is an effective statistical tool that can analyze complex relationships between latent variables. SEM combines the advantages of factor analysis and path analysis to process measurement models and structural models. This article uses SEM to explore the effectiveness of diversified teaching strategies in university physical education courses, and their impacts on students' participation willingness, course grades, and satisfaction are specifically analyzed.

3.5 SEM Model Construction

1) Latent variables and observed variables

In this article, latent variables cannot be directly observed and need to be measured through observed variables. Specifically, diversified teaching strategies, as latent variables, cover teaching methods, teaching resources, personalized teaching strategies, and interactive activities, which evaluate students' satisfaction and usage of relevant aspects through items in the questionnaire. Students' participation willingness reflects their enthusiasm and engagement in physical education courses, and the observed variables include attendance rate, classroom activity participation frequency, and willingness to exercise outside of class. The course grades cover theoretical knowledge, practical skills, and classroom performance, with observed variables being final exam scores, motor skills test results, and classroom performance ratings. Course satisfaction refers to the overall level of student satisfaction with the course, measured through feedback on the course and satisfaction ratings of teaching effectiveness.

2) Path design

Based on the proposed hypotheses and theoretical framework, this article designs the following path to demonstrate causal relationships between latent variables: firstly, it is assumed that multiple teaching methods can significantly increase students' participation willingness; secondly, it is believed that abundant teaching resources can promote learning outcomes, thereby improving course grades; thirdly, personalized teaching strategies based on individual student needs and physical abilities are expected to have a significant impact on improving student performance; finally, it is assumed that classroom activities with strong interactivity can significantly improve students' course satisfaction. The theoretical framework of the study in this article is constructed based on these hypotheses for in-depth analysis of the effectiveness of diversified teaching strategies.

3) Initial model construction

Based on the above path design, this article constructs an initial structural equation model, which includes two parts: the measurement model and the structural model. The measurement model demonstrates how to measure different dimensions of diversified teaching strategies, as well as students' participation willingness, course grades, and course satisfaction, through specific questionnaire items. The equation of the measurement model is as follows:

$$X_i = \lambda_i \cdot \xi + \delta_i \qquad (4)$$

Among them, X_i is the observed variable; ξ is the latent variable; λ_i is the load factor; δ_i is the error term. The structural model reflects the causal relationship between latent variables. The equation is:

$$\eta = \beta \cdot \tau + \zeta \qquad (5)$$

Among them, η is the dependent variable; τ is the independent variable; β is the path coefficient; ζ is the error term. The initial model assumes that all paths have significant and positive effects. The specific path coefficients are estimated through actual data in the model fitting and validation section.

In the SEM, the measurement model and the structural model are closely connected. The measurement model ensures that the observed variables accurately reflect the latent variables. If the measurement model is inaccurate, the analysis of the structural model may produce misleading conclusions. Therefore, the measurement model provides a foundation for defining and measuring latent variables. On this basis, the structural model analyzes the causal relationships between latent variables and reveals their interactions. The path analysis of structural models relies on the accuracy of measurement models, and the effective combination of the two helps to deepen understanding of complex potential relationships and validate theoretical hypotheses. Figure 2 displays the SEM model structure constructed based on this article:

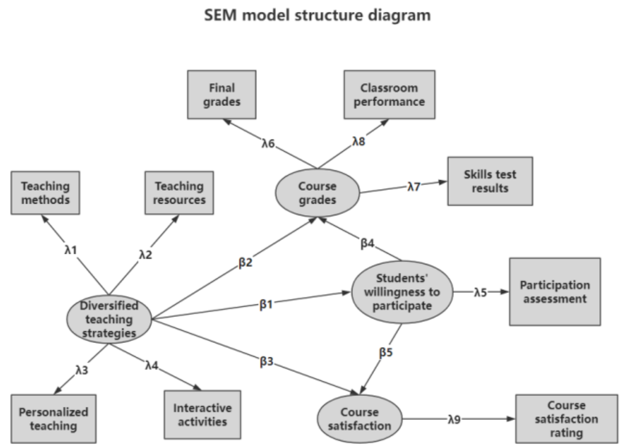

Figure 2. SEM model structure diagram

3.6 Multiple Linear Regression Model Construction

The multiple linear regression model is used to analyze the relationships between multiple independent variables and a dependent variable. In this article, a multiple linear regression model is used to explore how the dimensions of diversified teaching strategies such as different teaching resources and personalized teaching strategies affect students' course grades as the dependent variable. The process of model construction includes variable definition, model equation setting, and hypothesis formulation.

(1) Variable design

In a multiple linear regression model, several independent variables are selected as factors that affect students' course grades. According to the research objectives of this article, the following independent and dependent variables are determined:

Independent variables (X): satisfaction with teaching methods, satisfaction with teaching resources, and satisfaction with interactive activities;

Dependent variable (Y): students' course grades.

(2) Model equation setting

In a multiple linear regression model, the dependent variable Y can be seen as a linear combination of the independent variable X. Assuming that independent variables X_1, X_2, ..., X_p represent the dimensions of different teaching strategies, the basic form of the multiple linear regression model in this article is:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_p X_p + \epsilon \qquad (6)$$

Among them, Y is the students' course grades. β_0 is the intercept term, which represents the benchmark value of course grades when all independent variables are 0. β_1, β_2, ..., β_p are the regression coefficients of the independent variables, indicating the degree of influence of each independent variable on the dependent variable. X_1, X_2, ..., X_p are independent variables such as satisfaction with teaching methods, satisfaction with teaching resources, and satisfaction with interactive activities, respectively. ϵ is the error term, representing the impact of other factors that cannot be explained in the model on course grades.

(3) Hypothesis proposal

Based on the previous research hypotheses and theoretical framework, this article proposes the following hypotheses in the multiple linear regression model:

Hypothesis 1: teaching methods have a significant impact on students' course grades.

Hypothesis 2: the use of different types of teaching resources is significantly correlated with students' course grades.

Hypothesis 3: incorporating highly interactive activities has a significant positive impact on students' course grades.

These hypotheses are validated through significance tests of the regression coefficients β_1, β_2, ..., β_p of the model.

(4) Data preparation

The independent and dependent variables of the multiple linear regression model are both sourced from the preprocessed dataset mentioned earlier. The data goes through preprocessing steps such as missing value filling, outlier handling, standardization, and categorical variable encoding, ensuring the applicability and analyzability of the data in the model.

3.7 Model Fitting and Validation

After the model construction is completed, the preprocessed data is used to fit and validate the model, in order to evaluate its adaptability and predictive ability.

1) Fitting and validation of SEM model

Fitting process:

In this article, SEM is used to verify the impact of diversified teaching strategies on students' participation willingness, course grades, and course satisfaction. This article uses the maximum likelihood estimation (MLE) method to estimate the parameters of path coefficients and measurement models. (Liu and Liu, 2024; Lemes et al. 2021). Based on the data obtained from the questionnaire survey in the previous section and the model path diagram drawn, the Mplus software is used to implement the automatic fitting process of the SEM model. Table 1 presents some data:

Table 1. Model fitting input table

Student ID	Satisfaction with teaching methods	Satisfaction with teaching resources	Satisfaction with interactive activities	Participation willingness	Course grades	Course satisfaction
001	4.2	4.5	3.8	4.1	88	4.0
002	3.7	3.9	4.2	3.8	80	4.3

003	4.5	4.0	4.5	4.6	90	4.6
004	3.9	3.7	3.9	3.9	84	4.1
005	4.1	4.4	4.0	4.2	87	4.5
006	4.3	4.2	4.1	4.3	85	4.2
007	3.8	3.6	3.7	3.7	79	3.9
008	4.0	4.1	4.2	4.0	86	4.4
009	4.4	4.3	4.5	4.5	89	4.5
010	3.6	3.8	3.9	3.6	81	4.0

Evaluation of model goodness-of-fit:

Model goodness-of-fit is used to measure the degree of match between theoretical models and actual data. This article evaluates the fitting effect of the SEM model through several commonly used goodness-of-fit indexes. The goodness-of-fit index and its fitting results used in this article are as follows:

Chi-square test (X^2): chi-square test is used to compare the differences between observed data and model predictions, and its calculation formula is as follows:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i} \tag{7}$$

Among them, O_i is the observed data, and E_i is the model predicted value. The closer the model is to the data, the smaller the chi-square value.

Comparative fit index: the calculation formula of CFI is:

$$\text{CFI} = 1 - \frac{X^2{}_{Model} - df_{Model}}{X^2{}_{Independent\ Model} - df_{Independent\ Model}} \tag{8}$$

Among them, $X^2{}_{\text{Model}}$ and df_{Model} are the chi-square values and degrees of freedom of the model, respectively, and $X^2{}_{\text{Independent Model}}$ and $df_{\text{Independent Model}}$ are the chi-square values and degrees of freedom of the independent model.

Root mean square error of approximation: RMSEA reflects the balance between model simplicity and adaptability. The calculation formula is:

$$RMSEA = \sqrt{\frac{\chi^2/df - 1}{N - 1}} \tag{9}$$

Normed fit index: the calculation formula is:

$$\text{NFI} = \frac{X^2{}_{Independent\ Model} - X^2{}_{Model}}{X^2{}_{Independent\ Model}} \tag{10}$$

Tucker-Lewis index: TLI is used to compare the differences between the fitting model and the base model, and its formula is:

$$\text{TLI} = \frac{X^2{}_{Independent\ Model}/df_{Independent\ Model} - X^2{}_{Model}/df_{Model}}{X^2{}_{Independent\ Model}/(df_{Independent\ Model} - 1)} \tag{11}$$

The data, model structure, and path relationships are input into Mplus, and Table 2 shows the resulting indexes:

Table 2. Fitting index data table

Index	Standard value	Results of this article	Fitting effect
CFI	>0.90	0.94	Good
RMSEA	<0.06	0.056	Good
NFI	>0.90	0.93	Good
TLI	>0.90	0.92	Good
Chi-square value/degrees of freedom (χ^2/df)	<2	1.60	Good

From the fitting indexes in Table 2, it can be seen that the SEM model of this article has a good fitting effect and can effectively explain the potential relationships in the data.

Path coefficient estimation results: the standardized path coefficients and their statistical test results for each path in the model output by Mplus are shown in Table 3:

Table 3. Standardized path coefficients and their statistical test results

Path	Standardized path coefficients	Standard error	t-value	p-value	Significance results
Teaching methods → Students' participation willingness	0.45	0.06	7.5	0.001	Significant positive correlation
Teaching resources → Course grades	0.32	0.07	4.57	0.002	Significant positive correlation
Personalized teaching strategies → Course grades	0.41	0.06	6.83	0.000	Significant positive correlation
Interactive activities → Course satisfaction	0.48	0.08	6.00	0.000	Significant positive correlation

Explanation of path coefficients:

According to the data in Table 3, the path coefficient of teaching methods on students' participation willingness is 0.45 (t-value of 7.5 and p-value of 0.001), indicating that the diversity of teaching methods significantly enhances students' participation willingness. The path coefficient of teaching resources on course grades is 0.32 (t-value of 4.57 and p-value of 0.002), indicating that abundant teaching resources significantly improve students' grades. The path coefficient of personalized teaching strategies is 0.41 (p-value of 0.000), indicating that personalized teaching can effectively improve grades as it better adapts to students' needs and interests. The path coefficient of interactive activities on course satisfaction is 0.48 (p-value of 0.000), indicating that increasing interactive activities significantly improves student satisfaction. Overall, the analysis results of the structural equation model indicate that applying diversified teaching strategies into university physical education courses can effectively enhance students' learning experience and grades.

2) Fitting of multiple linear regression model

This article uses a multiple linear regression model to explore the impact of multiple dimensions of diversified teaching strategies, such as satisfaction with teaching methods, satisfaction with teaching resources, and satisfaction with interactive activities, on students' course grades. The model equation is as shown in Formula (6). The model fitting is performed using ordinary least squares (OLS) to estimate the degree of influence of independent variables on the dependent variable (student course grades), and the significance of the model is tested. Gomila, R. (2021). Table 4 shows some data used for regression analysis:

Table 4. Regression analysis data table

Student ID	Satisfaction with teaching methods	Satisfaction with teaching resources	Satisfaction with interactive activities	Course grades
011	4.5	4.5	4.5	90
012	4.0	4.1	4.2	85
013	4.5	4.4	4.5	92
014	4.2	4.0	4.1	88
015	4.4	4.3	4.4	91
016	4.1	4.2	4.1	87
017	4.3	4.1	4.2	89
018	4.5	4.5	4.5	93
019	4.0	4.0	4.1	84
020	4.2	4.3	4.2	86

The data in Table 4 is input into Mplus for fitting, and the fitting results are shown in Table 5:

Table 5. Fitting results of multiple linear regression model

Independent Variable	Regression coefficient (β)	Standard error	t-value	p-value	Significance	R^2
Intercept (β_0)	50.23	5.43	9.25	< 0.001	***	0.785
Satisfaction with teaching methods (X_1)	4.12	1.21	3.40	0.003	**	
Satisfaction with teaching resources (X_2)	3.87	1.34	2.89	0.008	**	
Satisfaction with interactive activities (X_3)	2.94	1.05	2.80	0.010	*	

According to the data in Table 5, for every unit increase in satisfaction with teaching methods, students' course grades improve by an average of 4.12 points (β_1=4.12). For every unit increase in satisfaction with teaching resources, the average course grades increase by 3.87 points (β_2=3.87).

For every unit increase in satisfaction with interactive activities, the average course grades increase by 2.94 points (β_3=2.94). The p-value of satisfaction with teaching methods is 0.003; the p-value of satisfaction with teaching resources is 0.008; the p-value of satisfaction with interactive activities is 0.010. These are all less than 0.05, indicating that their impact on course grades is statistically significant. Meanwhile, the R^2 value of the model is 0.785, indicating that the independent variable explains 78.5% of the variance in course grades, demonstrating strong explanatory power. These results validate the hypothesis 2 that diversified teaching strategies significantly improve students' course grades.

The residual analysis is conducted on the data in Table 4, and the resulting residual graph is presented in Figure 3:

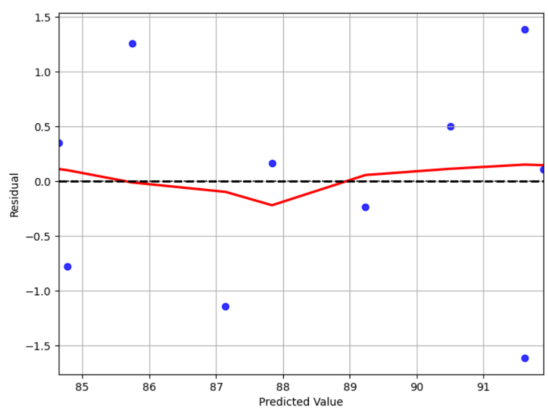

Figure 3. Residual graph

The blue dots in Figure 3 represent the residuals of each observed value. Specifically, the horizontal axis of the blue dot represents the course grades predicted by the model based on independent variables such as satisfaction with teaching methods, satisfaction with teaching resources, and satisfaction with interactive activities. From Figure 3, it can be found that the blue dots in the residual graph are randomly distributed and have no obvious trend or pattern, indicating that the model fits well. The red curve is the locally weighted regression curve of residuals, also known as the LOESS curve (locally estimated scatterplot smoothing). It is close to the horizontal line, indicating that the model fits well.

The regression analysis results show that satisfaction with teaching methods, teaching resources, and interactive activities all have a significant impact on students' course grades. Among them, the regression coefficient of satisfaction with teaching methods is the highest, indicating that it has the most significant effect on improving grades. The R^2 value of the model further validates the explanatory power of these diversified teaching strategy dimensions on changes in students' grades. These results support the important role of diversified teaching strategies in improving the performance of university physical education courses.

4. DISCUSSION

4.1 Discussion on Hypotheses Validation Results

This article verifies the hypotheses through SEM and multiple linear regression models and draws the following main conclusions:

Hypothesis 1: diversified teaching strategies have a significant positive impact on students' participation willingness.

Validation result: the SEM model results show that the standardized path coefficient of teaching methods on students' participation willingness is 0.45 (t=7.5, p=0.001), indicating a significant positive correlation of this path. The regression model results also support this conclusion, with a regression coefficient of 4.12 (t=3.40, p=0.003) for satisfaction with teaching methods, indicating that diversified teaching strategies significantly enhance students' participation willingness. Therefore, hypothesis 1 is validated, demonstrating that diversified teaching strategies can significantly increase students' participation willingness.

Hypothesis 2: diversified teaching resources have a significant positive impact on course grades.

Validation result: in the SEM model, the standardized path coefficient of teaching resources on course grades is 0.32 (t=4.57, p=0.002), indicating a significant positive impact. Regression analysis also shows that the regression coefficient for satisfaction with teaching resources is 3.87 (t=2.89, p=0.008). These results indicate that diversified teaching resources significantly improve students' course grades, validating hypothesis 2.

Hypothesis 3: personalized teaching strategies have a significant improvement effect on student performance.

Validation result: the SEM model results show that the standardized path coefficient of personalized teaching strategies on course grades is 0.41 (t=6.83, p=0.000), indicating a significant positive impact on course grades. Although the regression coefficients for personalized teaching strategies are not separately listed in the regression model, the overall model still demonstrates significant effects. Therefore, hypothesis 3 is validated, indicating that personalized teaching strategies effectively improve student performance.

Hypothesis 4: interactive activities have a significant impact on course satisfaction.

Validation result: according to SEM model data, the standardized path coefficient of interactive activities on course satisfaction is 0.48 (t=6.00, p=0.000), indicating a significant positive relationship between interactive activities and course satisfaction. The regression coefficient of satisfaction with interactive activities in the regression model is 2.94 (t=2.80, p=0.010), further supporting this conclusion. Hypothesis 4 is validated, indicating that interactive activities have a significant positive effect on improving students' course satisfaction.

4.2 Application in Actual Teaching

In actual teaching, to test the specific effectiveness of the conclusions in this article, diversified teaching strategies are applied to teaching practice. The specific experimental process is as follows:

1) Experimental design

Objective: the objective is to verify the actual effects of diversified teaching strategies on student performance, participation, and course satisfaction.

Experimental objects: samples are further randomly selected from 500 students randomly selected in this article, assuming that there are 250 students in the experimental group and 250 in the control group. It is ensured that the samples are representative and able to control potential biases.

2) Experimental steps

After dividing the experimental group and the control group, the initial intentions and grades of all students are recorded. In the experimental group, diversified teaching strategies are adopted within one semester. Various teaching methods such as flipped classroom, group cooperative learning, and case analysis are adopted for students, and diverse teaching resources are provided. Various interactive activities are also designed and implemented. In the control group, traditional teaching methods are used, with traditional lectures as the main teaching strategy and teaching resources relying on conventional paper textbooks and standard teaching aids, and there are a few interactive activities. The experimental process lasts for one semester, and after one semester, the course grades, participation willingness, and course satisfaction of the two groups of students are compared again.

3) Experimental results

The comparison of the results between the experimental group and the control group in the early and later measurements is shown in Table 6:

Table 6. Comparison data in the early and later measurements

Measuring indicators	Group	Mean of early measurements	Mean of later measurements	Average difference	t-value	p-value	Significance of results
Course Grades	Experimental Group	75.4	85.7	10.3	7.45	<0.001	Significant positive correlation
	Control group	76.1	78.2	2.1	1.78	0.079	Not significant
Participation willingness	Experimental group	3.2	4.5	1.3	6.30	<0.001	Significant positive correlation
	Control group	3.1	3.2	0.1	0.87	0.387	Not significant
Course satisfaction	Experimental group	3.5	4.4	0.9	5.40	<0.001	Significant positive correlation
	Control group	3.4	3.6	0.2	1.50	0.135	Not significant

According to the data in Table 6, diversified teaching strategies have a significant positive impact on course grades, participation willingness, and course satisfaction. The course grades of the experimental group significantly increase from 75.4 to 85.7, with an average increase of 10.3 points ($p<0.001$), indicating that this strategy effectively improves student grades. The grades of the control group only increase by 2.1 points, and there is no significant change ($p=0.079$). In terms of participation willingness, the experimental group increases from 3.2 to 4.5, with an increase of 1.3 points ($p<0.001$). The control group only increases by 0.1 points ($p=0.387$), with no significant change. The course satisfaction also significantly increases in the experimental group, from 3.5 to 4.4 ($p<0.001$), while there is no significant improvement in the control group ($p=0.135$). These results indicate that diversified teaching strategies are significantly superior to traditional methods.

5. CONCLUSION

This article explores the impact of diversified teaching strategies on students' participation willingness, course grades, and satisfaction in university physical education courses through empirical analysis. The results show that diversified teaching strategies significantly improve students' course grades (from 75.4 points to 85.7 points), participation willingness (from 3.2 to 4.5), and course satisfaction (from 3.5 to 4.4), confirming their positive impacts on learning outcomes. Therefore, it is recommended to widely apply personalized teaching and interactive activities in university physical education courses to meet students' needs, enhance their sense of participation and satisfaction. However, this article has certain limitations in sample selection, data collection, and model construction, which may affect the accuracy of the results. Future research should expand to other disciplines and a wider sample and delve into the performance differences of different groups to improve the reliability and applicability of the results.

REFERENCES

Atik, S., Celik, OT. (2021). Analysis of the relationships between academic motivation, engagement, burnout and academic achievement with structural equation modelling. International Journal of Contemporary Educational Research, 8(2): 118-130.

Block, ME., Haegele, J., Kelly, L., et al. (2021). Exploring future research in adapted physical education. Research Quarterly for Exercise and Sport, 92(3): 429-442.

Calderón, A., Scanlon, D., MacPhail, A, et al. (2021). An integrated blended learning approach for physical education teacher education programmes: teacher educators' and pre-service teachers' experiences. Physical Education and Sport Pedagogy, 26(6): 562-577.

Dahouda, MK, Joe, I. (2021). A deep-learned embedding technique for categorical features encoding. IEEE Access, 9: 114381-114391.

Demchenko, I., Maksymchuk, B., Bilan, V. (2021). Training future physical education teachers for professional activities under the conditions of inclusive education. BRAIN. Broad Research in Artificial Intelligence and Neuroscience, 12(3): 191-213.

Fu, J., Jiang, S. (2024). Using the Information Systems Success Model to Predict Factors Affecting Intention to Adopt Blended Learning in Physical Education. Revista de Psicología del Deporte (Journal of Sport Psychology), 33(2): 444-457.

Gheyssens, E., Coubergs, C., Griful-Freixenet, J. et al. (2022). Differentiated instruction: the diversity of teachers' philosophy and praxis to adapt teaching to students' interests, readiness and learning profiles. International Journal of Inclusive Education, 26(14): 1383-1400.

Gil-Arias, A., Harvey, S., García-Herreros, F. (2021). Effect of a hybrid teaching games for understanding/sport education unit on elementary students' self-determined motivation in physical education. European Physical Education Review, 27(2): 366-383.

Gomila, R. (2021). Logistic or linear? Estimating causal effects of experimental treatments on binary outcomes using regression analysis. Journal of Experimental Psychology: General, 150(4): 700-710.

Halvorson, MA, McCabe, CJ., Kim, DS., et al. (2022). Making sense of some odd ratios: A tutorial and improvements to present practices in reporting and visualizing quantities of interest for binary and count outcome models. Psychology of Addictive Behaviors, 36(3): 284-324.

Hernando-Garijo, A., Hortiguela-Alcala, D., Sanchez-Miguel, PA., et al. (2021). Fundamental pedagogical aspects for the implementation of models-based practice in physical education. International Journal of Environmental Research and Public Health, 18(13): 7152-7164.

Khan, A., Ghosh, SK. (2021). Student performance analysis and prediction in classroom learning: A review of educational data mining studies. Education and information technologies, 26(1): 205-240.

Lemes, VB., Gaya, ACA., Brand, C., et al. (2021). Associations among psychological satisfaction in physical education, sports practice, and health indicators with physical activity: Direct and indirect ways in a structural equation model proposal. International Journal of Pediatrics and Adolescent Medicine, 8(4): 246-252.

Leng, S., Shao, M. (2022). A Study on the Effect of the Club Model on the Effectiveness of College Volleyball Teaching Based on a Random Matrix Model. Mathematical Problems in Engineering, 2022(1): 5681412-5681424.

Liu, Y., Liu, B. (2024). A modified uncertain maximum likelihood estimation with applications in uncertain statistics. Communications in Statistics-Theory and Methods, 53(18): 6649-6670.

Merza, EO., Mohammed, NJ. (2021). Fast Ways to Detect Outliers. Journal of Techniques, 3(1): 66-73.

Montoya, AK., Edwards, MC. (2021). The poor fit of model fit for selecting number of factors in exploratory factor analysis for scale evaluation. Educational and psychological measurement, 81(3): 413-440.

Moustakas, L., Robrade, D. (2022). The challenges and realities of e-learning during COVID-19: The case of university sport and physical education. Challenges, 13(1): 9-21.

O'Neill, G., Padden, L. (2021). Diversifying assessment methods: Barriers, benefits and enablers. Innovations in education and teaching international, 59(4): 398-409.

Pasira, I. (2022). Assessing the effectiveness of differentiated instruction strategies in diverse classrooms. Journal of Education Review Provision, 2(1): 31-36.

Raiola, G. (2023). University training for physical education teachers, sports and preventive and adapted physical activities kinesiologists and sports manager. Acta Kinesiologica, 17(1.): 55-59.

Sathyanarayana, S., Mohanasundaram, T. (2024). Fit Indices in Structural Equation Modeling and Confirmatory Factor Analysis: Reporting Guidelines. Asian Journal of Economics, Business and Accounting, 24(7): 561-577.

Shi, D., DiStefano, C., Maydeu-Olivares, A., et al. (2022). Evaluating SEM model fit with small degrees of freedom. Multivariate behavioral research, 57(2-3): 179-207.

Sijtsma, K., Pfadt, JM. (2021). Part II: On the use, the misuse, and the very limited usefulness of Cronbach's alpha: Discussing lower bounds and correlated errors. Psychometrika, 86(4): 843-860.

Sun, J,. Xia, Y. (2024). Pretreating and normalizing metabolomics data for statistical analysis. Genes & Diseases, 11(3): 100979-100997.

Tremblay-Wragg, E., Raby, C., Menard, L. et al. (2021). The use of diversified teaching strategies by four university teachers: what contribution to their students' learning motivation?. Teaching in Higher Education, 26(1): 97-114.

Varea, V., Gonzalez-Calvo. G., Garcia-Monge, A. (2022). Exploring the changes of physical education in the age of Covid-19. Physical Education and Sport Pedagogy, 27(1): 32-42.

Wang, Y., Sun, C., Guo, Y. (2021). A multi-attribute fuzzy evaluation model for the teaching quality of physical education in colleges and its implementation strategies. International Journal of Emerging Technologies in Learning (IJET), 16(2): 159-172.

West, RM. (2022). Best practice in statistics: The use of log transformation. Annals of Clinical Biochemistry, 59(3): 162-165.

Ximenez, C., Maydeu-Olivares. A., Shi, D., et al. (2022). Assessing cutoff values of SEM fit indices: Advantages of the unbiased SRMR index and its cutoff criterion based on communality. Structural Equation Modeling: A Multidisciplinary Journal, 29(3): 368-380.