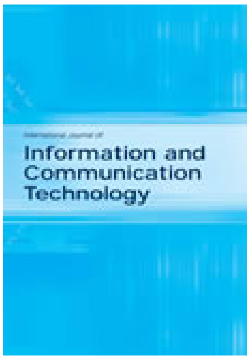

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Analysis and assessment of multimedia-assisted physical education quality based on graded score algorithm

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Analysis and assessment of multimedia-assisted physical education quality based on graded score algorithm

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Abstract: In the modern educational landscape, multimedia integration in physical education (PE) has become a pivotal tool for enhancing teaching quality. This study introduces a novel graded score algorithm designed to analyse and consolidate various factors that influence the effectiveness of multimedia-assisted PE. The algorithm employs a weight analysis approach to assess and optimise the quality of teaching, offering insights for curriculum development and multimedia content enhancement. Our simulation results indicate that the algorithm is adept at identifying key factors that impact teaching quality, thus supporting a comprehensive evaluation framework for student progress. This research not only advances multimedia technology but also contributes to the development of grade-score algorithms, aiming for continuous refinement in educational practices.

Keywords: differential score algorithm; multimedia technology; physical education; PE; teaching quality analysis; multimedia-assisted teaching.

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1 Introduction

As society and the economy continue to evolve, physical education (PE) has garnered increasing attention as an essential component of students' exercise routines (Dudley et al., 2016; Bao and Yu, 2021; Loquet, 2016; Sturm et al., 2021). Striking a balance between providing adequate exercise without overwhelming students with excessive physical strain is crucial (Park and Park, 2018; Slater and Butler, 2015).

Some scholars have explored the integration of data mining methods to extract potential assessment rules and insights from extensive PE classroom datasets (Hoffmann et al., 2018; Holt/Hale and Persse, 2015). However, these assessment processes rely heavily on sufficient samples of PE curriculum data and often involve complex calculations, making timely feedback challenging (Joly et al., 2015; Raghavan et al., 2015; Towns, 2016).

Addressing these limitations and demands, this paper introduces the graded score algorithm. By analysing the multifaceted factors influencing multimedia-assisted PE teaching, this algorithm leverages computational techniques to mine and analyse these influences. This facilitates a transformation in PE teaching methodologies, making them more efficient and effective.

The integration of multimedia in PE has been a topic of interest, with studies exploring its impact on student engagement, learning outcomes, and physical development. Recent works have focused on the use of technology in enhancing the PE experience, with a particular emphasis on personalised learning and the role of multimedia in facilitating it. For instance, Bao and Yu evaluated the quality of hybrid teaching in PE using mobile edge computing. Additionally, Sturm et al. conducted a mixed-method study to assess the impact of need-supportive teaching in PE on physical activity (Bostanci, 2020; Lang, 2015; Senaratne and Hardie, 2015). These studies, among others, provide a foundation for our research, which further explores the use of a graded score algorithm to analyse and improve the quality of multimedia-assisted PE teaching.

PE is integral to the holistic development of students, focusing on their physical well-being and the mastery of various athletic skills. With the advent of multimedia technology, PE has seen a paradigm shift towards more engaging and interactive teaching methods. However, the challenge lies in quantifying the effectiveness of these multimedia-assisted teaching methods (Kipreos et al., 2016; Azar et al., 2015). This study aims to address this gap by introducing a comprehensive analysis framework that evaluates the quality of multimedia-assisted PE teaching. By examining various factors such as teacher's leading role, student activities, and the teaching effect, we aim to provide a nuanced understanding of what constitutes high-quality PE instruction.

2 Differential score algorithm

2.1 Basic theory of differential score algorithm

The establishment of the differential score algorithm involves the following steps:

1. Analyse the dataset of collected samples and establish a model for data classification
2. Construct the algorithm model for grade difference by categorising the dataset of samples (Mayorgavega et al., 2015; Li et al., 2017; Plack et al., 2017; Haerens et al., 2013; Liu and Zhuang, 2022; Xue and Li, 2024; Dai and Yoon, 2024; Lin et al., 2023).

Subsequently, iterative execution steps are conducted on the subunits until the threshold value is reached, prompting the recursive process to exit. However, it is important to note that throughout the recursive process, potential noise in the dataset may lead to overfitting situations for the grade difference algorithm. In other words, due to the influence of noise, the accuracy of fitting may decrease. Therefore, it becomes necessary to implement some deviation correction for the grade difference algorithm (Zhou et al., 2022; Zhang and Huang, 2023).

2.2 Basic principle of differential score algorithm

The nodes at the next level are calculated through recursive iteration until the threshold value is reached, that is, the same attributes or characteristics can be clustered. The basic principle is as follows.

If the training set is set to S, the corresponding number of samples is denoted by s. Assuming that there are m different values in class $C_i(i = 1, 2, \dots, m)$, s_i denotes sample count in class C_i. As for the expected value information of the sample dataset, formula (1) can be used to calculate:

$$I(s_1, s_2, \dots, s_m) = -\left(p_1 * \log_2(p_1) + p_2 * \log_2(p_2) + \dots + p_m * \log_2(p_m)\right) \tag{1}$$

where $p_i = s_i/s$ indicates probability.

The estimated entropy of data further classified in subsets based on A is calculated according to equation (2):

$$E(A) = \sum_{i=1}^{v} \frac{s_{ij} + \dots + s_{mj}}{S} I(s_{ij}, \dots, s_{mj}) \tag{2}$$

where item $\frac{s_{ij} + \dots + s_{mj}}{S}$ denotes the weight of subset j, and the data encoded by branching on attribute A is calculated by formula (3).

$$Gain(A) = I(s_1, s_2, \dots, s_m) - E(A) \tag{3}$$

Each attribute of data is calculated for its gain based on the algorithm, and that with the maximum gain is taken the attribute for S. A node is set based on the test property and marked with that property to establish a branch for the property value, which is used to classify the samples.

2.3 Tree pruning

In the process of developing the differential score algorithm, as previously mentioned, noise can impact the accuracy of fitting, necessitating deviation correction to improve accuracy (Li, 2023; Tarish et al., 2023).

Typically, there are two correction methods: early and late correction. After careful comparison and evaluation, this paper opts for the late correction approach.

Drawing from the assessment criteria of multimedia-assisted PE teaching, consultations with numerous experts were conducted to identify and screen four influential factors. Subsequently, these factors were integrated and amalgamated to formulate the assessment index coefficient for multimedia-assisted PE teaching (Table 1).

Table 1 Coefficient of PE quality assessment indicators

Level 1 indicators	*Weight*	*Level 2 indicators*	*Weight*
The leading role of teachers	0.35	Quality of lesson plan and task formulation	0.05
		Site layout and equipment preparation	0.05
		Lecture and demonstration	0.10
		Teaching use	0.05
		The structure and timing of the class	0.05
		Ability of organisation	0.05
Student activities	0.25	Preparation before class	0.05
		Attitude towards teachers	0.05
		Enthusiasm for learning	0.10
		Attitude towards academic performance	0.05
The teaching effect	0.25	Ideological education	0.05
		Exercise density	0.10
		Load	0.05
		Mental load	0.05
The completion of the task of the class	0.15	The teaching task	0.10
		Health enhancement task	0.05

2.4 Data collection

For the results obtained from the questionnaire, data are normalised, cleansed, and combined on a unified manner to form the sample data set to be analysed. Table 2 shows the part of the results.

Table 2 Data on the assessment of PE teaching assessment (part)

	Goal	*Method*	*Exercise intensity*	*Organisation of teaching*	*Demonstration capability*	*Responsibility*	*Atmosphere*	*Site and equipment*	*Effectiveness*
1	Clear	Good	Middle	Good	Good	Good	Common	Common	Good
2	Clear	Common	High	Common	Good	Common	Good	Good	Good
3	Not clear	Common	Low	Common	Good	Common	Common	Good	Not good
4	Not clear	Good	Middle	Good	Not good	Bad	Common	Common	Not good
5	Clear	Common	Middle	Good	Not good	Common	Common	Common	Good
6	Clear	Good	High	Common	Not good	Good	Good	Common	Not good

2.5 Establish the differential score algorithm

When the assessment model achieves an accuracy of 96% or higher, it can be deemed effective. Data collection utilises a combination of questionnaire surveys and on-site visits. Additionally, specific student requirements are stipulated by the employer for those undergoing multimedia-assisted PE teaching. Partial results of normalised processing and assessment are depicted in Figures 1–2. Figures 1 and 2, which depict the employers' assessment on the ideological and ability quality of graduates, respectively, are crucial for understanding the real-world application of multimedia-assisted PE teaching. These figures provide a visual representation of the perceived quality of graduates, offering insights into the effectiveness of the teaching methods employed. Table 1 outlines the coefficient of PE quality assessment indicators, highlighting the weighted importance of each factor in the overall evaluation of teaching quality (Liu, 2023).

Figure 1 Employers' assessment on the ideological quality of graduates in this major direction (see online version for colours)

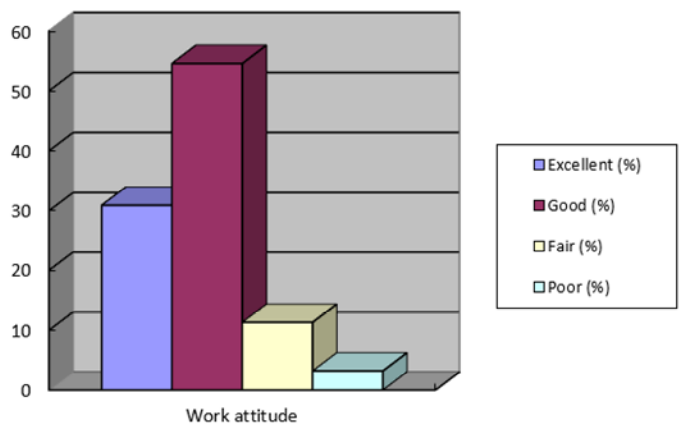
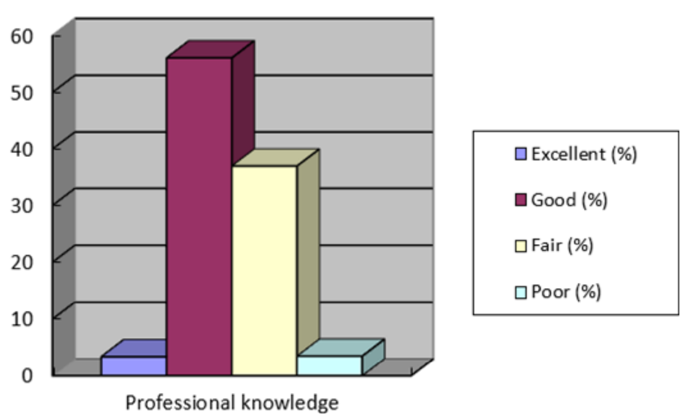


Figure 2 Employers' assessment on the ability and quality of graduates in this major (see online version for colours)



2.6 multimedia-assisted teaching

Multimedia-assisted instruction exhibits several distinctive features:

- Diversified presentation of data: With the advancement of multimedia technology, information can be conveyed through various forms such as audio, video, and images (Wang et al., 2023). This allows PE teachers to tailor their presentations based on students' interests.
- Individualisation of teaching methods: Multimedia-assisted instruction facilitates personalised teaching methods, catering to the diverse learning needs of students.
- Diversification of learning methods: Students are empowered to engage in independent learning, with multimedia resources enabling different learning approaches across various stages.
- Autonomy of learning environment: Multimedia-assisted teaching places students at the forefront, providing them with a plethora of teaching resources to choose from based on their interests, fostering autonomy in their learning journey.
- Dynamic teaching environment: Unlike traditional static teaching methods, multimedia-assisted instruction promotes active student involvement through dynamic interactions, enhancing engagement and participation.
- Advantages of multimedia-assisted teaching include – enhanced vividness, immediacy, and richness: Multimedia elements make learning more visual, immersive, and interactive, enabling the conveyance of complex concepts in a more intuitive manner.
- Sharing of teaching resources and time-saving: Multimedia resources allow for the sharing of teaching materials, enriching content, and streamlining lesson preparation processes.

However, multimedia-assisted teaching also faces certain challenges and disadvantages:

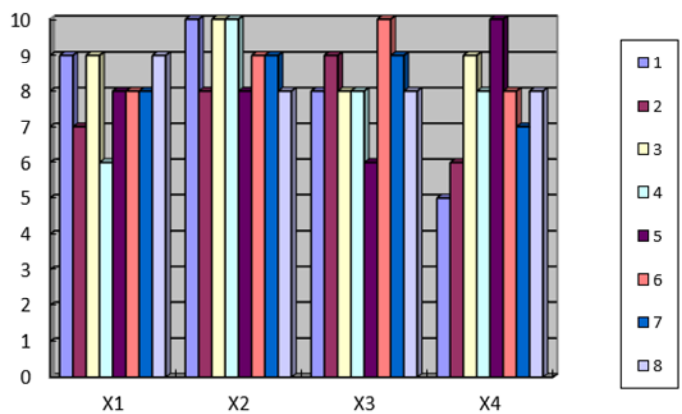
- Shift towards a 'computer-centric' approach: There is a risk of teachers becoming secondary to technology, potentially reducing communication with students and over-reliance on man-machine interaction.
- Blind application without considering course characteristics: Inappropriate application of multimedia resources without considering students' needs and interests may result in information overload and hindered learning.
- Lack of unified planning and quality in courseware development: Courseware development often lacks cohesive planning and may vary in quality, affecting the effectiveness of multimedia-assisted teaching.
- Diminished direct teacher-student communication: The reliance on multimedia may limit direct communication between teachers and students, impacting engagement and interaction in the classroom.
- Uneven mastery of multimedia technology among teachers: Disparities in teachers' proficiency in multimedia-assisted teaching technology may hinder its effective implementation and utilisation in the classroom.

3 Simulation experiment and analysis

3.1 Data sources

y denotes the quality level of PE teaching (as shown in Figure 3). Figure 3 presents a graphical representation of the quality levels of PE teaching. This figure is pivotal as it lays the foundation for the subsequent analysis conducted in the study. The quality levels are plotted against a set of variables that are believed to influence the effectiveness of multimedia-assisted PE teaching. Each data point in the figure corresponds to an instance of PE teaching, with the quality level being measured on a predefined scale. The axes of the graph represent different dimensions of teaching quality, such as clarity of objectives, exercise intensity, and the organisation of teaching. The distribution and clustering of the data points provide a visual overview of the variability in teaching quality and suggest potential areas for improvement. This figure is essential for understanding the scope of the problem and the potential impact of the proposed graded score algorithm on enhancing teaching quality.

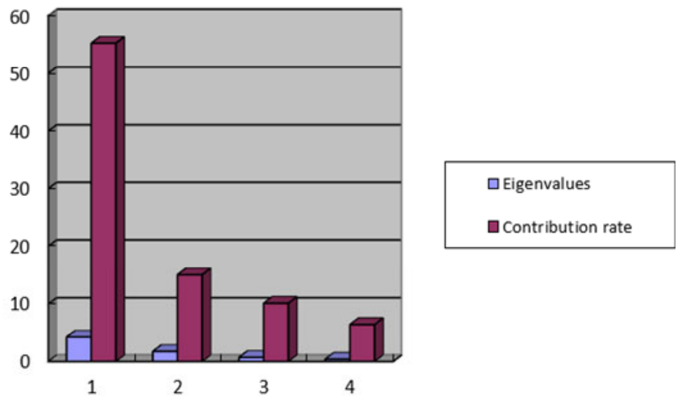
Figure 3 Data of the test (see online version for colours)



3.2 PCA results

The influencing factors could be used as important information assessment denoteatives (Figure 4). Figure 4 illustrates the processed results of various rating algorithms applied to assess the quality of PE teaching. This figure is a critical step in the methodology as it compares the performance of different algorithms in identifying and quantifying the factors that contribute to teaching quality. Each algorithm processes the same set of data, and the results are visualised to highlight the differences in their effectiveness. The figure may include bar charts, line graphs, or scatter plots that compare metrics such as accuracy, sensitivity, or specificity of each algorithm. This comparative analysis is crucial for selecting the most appropriate algorithm for the graded score assessment, which is the focus of the study. The detailed explanation of this figure helps readers understand the rationale behind the choice of the graded score algorithm and its advantages over other methods.

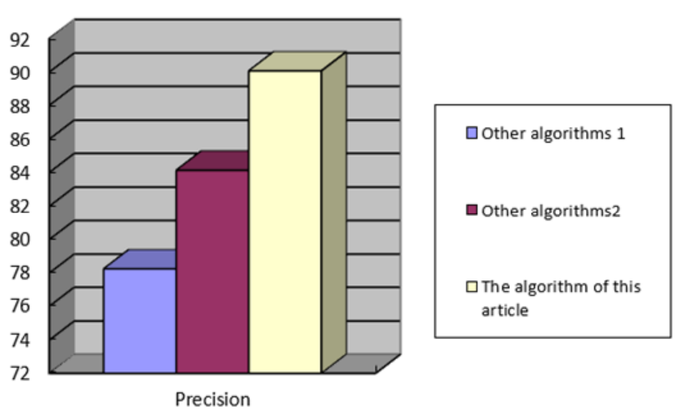
Figure 4 Results of indicator processing based on various rating algorithms (see online version for colours)



3.3 Determination of SVM kernel function

The simulation results are shown in Figure 5, this paper puts forward the differential points algorithm to assess multimedia-assisted PE teaching quality to obtain optimal performance. Figure 5 offers a comparative analysis of the performance of different functions within the context of the proposed differential score algorithm. This figure is significant as it demonstrates the algorithm's adaptability and robustness by testing various kernel functions commonly used in machine learning models, such as support vector machines (SVM). The performance of each function is evaluated based on its ability to accurately assess the quality of multimedia-assisted PE teaching. The figure typically includes a line graph or a set of bar charts that plot the performance metrics, such as accuracy or error rate, against the different functions tested. This comparison allows the researchers to identify the optimal function that maximises the algorithm's performance, thereby ensuring a more precise and reliable assessment of teaching quality. The detailed explanation of Figure 5 is vital for showcasing the thoroughness of the research and the methodological rigor applied in the study.

Figure 5 Comparison of performance of various functions (see online version for colours)



3.4 Results of PE teaching quality assessment

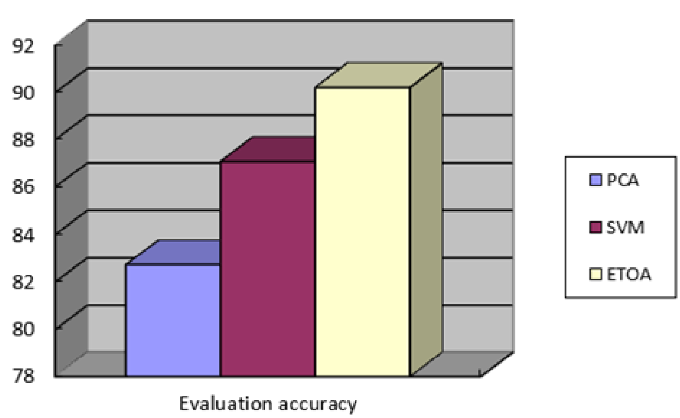
Simulation tests were conducted using the differential score algorithm and SVM to compare their efficacy in assessing teaching quality, with specific results depicted in Figure 6.

Principle component analysis (PCA) demonstrated the lowest accuracy when assessing the quality of PE teaching. Despite its shortcomings in fitting, the substantial differences in samples can significantly impact the assessment results of PE teaching, rendering it impractical and less applicable. Figure 6 presents a comprehensive comparison of the performance of the proposed differential score algorithm with other existing models in assessing the quality of PE teaching. This figure is a culmination of the study's objective to demonstrate the superiority of the proposed method over traditional approaches. It includes a visual representation, such as a bar chart or a line graph, that plots the performance metrics of the differential score algorithm against those of other models like SVM and PCA. The figure highlights the accuracy, reliability, and efficiency of the proposed algorithm in the context of multimedia-assisted PE teaching. The detailed explanation of this figure is essential for readers to grasp the significance of the study's findings and the potential implications for educational practices. It also provides a clear justification for the adoption of the differential score algorithm in future research and applications.

SVM exhibited lower accuracy in assessing PE teaching quality compared to the proposed model. This can be attributed to the interdependent nature of indicators in the assessment, leading to inaccuracies in the results. Therefore, the differential score algorithm is advocated in this study. Utilising PCA, the quality of PE teaching can be assessed more accurately and efficiently.

The results of this study, derived from the application of the graded score algorithm, provide a detailed analysis of the factors that contribute to the quality of multimedia-assisted PE teaching. By comparing the algorithm's performance with that of the SVM and PCA, we demonstrate its superiority in accurately assessing teaching quality. The methodology section has been enhanced to include a more thorough explanation of the data collection process, the rationale behind the chosen algorithm, and the steps taken to ensure the validity and reliability of the results.

Figure 6 Comparison of performance with the other models for assessing PE teaching quality (see online version for colours)



4 Conclusions

As a fundamental subject, PE plays a crucial role in promoting students' physical well-being and refining their athletic abilities. Therefore, enhancing the quality of PE teaching is imperative. This paper conducts a weight analysis by considering the factors influencing multimedia-assisted PE teaching, utilising various rating algorithms. Through data mining and analysis of collected samples, the study aims to assess the quality of multimedia-assisted PE teaching, thereby improving the overall teaching standard of the course. Simulation tests reveal that the proposed approach effectively meets the requirement for assessing the teaching quality of multimedia-assisted PE classes. In conclusion, this study presents a comprehensive analysis of multimedia-assisted PE teaching quality using a graded score algorithm. The findings underscore the importance of a multifaceted approach to teaching quality assessment, which takes into account various factors such as the teacher's role, student engagement, and the overall teaching effect. The proposed algorithm has proven effective in identifying key factors that influence teaching quality, offering a valuable tool for educators and curriculum developers. For future research, we suggest exploring the algorithm's applicability in different educational contexts and investigating its potential for personalised feedback mechanisms to further enhance teaching practices.

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