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# Human-computer interaction design of intelligent multimedia information technology in online sports teaching platform

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**Abstract:** With the advancement of information technology, intelligent multimedia has become essential in online physical education. This study explores human-computer interaction design in sports online teaching platforms, focusing on how intelligent multimedia technology enhances teaching effectiveness. Through experiments assessing student motivation, academic performance, and satisfaction of both students and teachers, results show that intelligent multimedia significantly boosts student engagement and learning outcomes. The design improves interaction, overcomes limitations of traditional teaching, and increases student satisfaction by 7.9%. It also enhances teacher satisfaction, demonstrating that intelligent multimedia integration promotes effective online physical education and supports digital education development.

**Keywords:** sports online teaching; intelligent multimedia; human-computer interaction; HCI; digital teaching.

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## 1 Introduction

Human-computer interaction (HCI) is the combination of computer, graphics and other related disciplines and software. This is an integral part of the growth of contemporary science and technology. HCI enables computers to process information, analyse and sort

out data. Physical education teaching is largely impacted by conventional educational ideas and perceptions. The online sports teaching platform is a new educational model that integrates multimedia technology, network communication and intelligent interaction, breaking through the limitations of time and space. It improves students' learning efficiency and sense of participation through video teaching, real-time interaction, personalised feedback and other means, and promotes the transformation of traditional sports teaching towards digitalisation and intelligence. It has broad application prospects and research value. The online sports teaching platform is a new education model, which can enable students to have an intuitive and efficient understanding of sports courses, and facilitate the development of sports education and studying online sports teaching platforms is very meaningful. Studying the different characteristics of online education platforms will help us to gain a deeper understanding of the differences in teaching models, functional design and user experience, thereby optimising platform development and application and improving teaching quality and learning outcomes.

This paper studies the HCI design of intelligent multimedia information technology in online sports teaching platforms, and systematically analyses the application mode of intelligent multimedia technology in sports teaching and its positive impact on teaching effects. By building an online teaching platform based on B/S architecture and combining PaaS and IaaS service models, an efficient and stable HCI environment is realised, and mathematical models such as motion detection and Kalman filtering are introduced to improve the intelligence level of the system. The experimental results show that compared with traditional teaching methods, online sports teaching based on intelligent multimedia significantly improves students' learning enthusiasm, test scores and satisfaction, and also improves teachers' teaching satisfaction. The innovation of this paper lies in the deep integration of HCI technology and sports teaching, and proposes a student-centred intelligent teaching platform design idea, and verifies its effectiveness through empirical research, providing theoretical support and a practical path for the digital transformation of physical education.

## 2 Related work

In recent years, with the continuous advancement of information technology, the application of intelligent multimedia technology in the field of education (Kotiash et al., 2022; Sudarmo et al., 2021) has become increasingly widespread, especially in physical education, showing good development potential. Existing studies have pointed out that the combination of multimedia (Zhou and Zhang, 2025; Wu and Liu, 2021), network communication and intelligent interaction can break through the time and space limitations of traditional physical education and improve learning efficiency and participation. Some studies focus on the design and optimisation of online teaching platforms, exploring key issues in teaching model innovation, functional module construction and user experience improvement. In addition, some scholars are concerned about how to enhance the expressiveness of teaching content (Bako, 2023) through multimedia technology, such as using video demonstrations, motion capture and real-time feedback to improve students' understanding and mastery of sports skills (Palvia, 2018). These studies provide theoretical support and technical basis for the HCI teaching platform based on intelligent multimedia proposed in this paper, and also reveal that

current research still needs to be deepened in personalised teaching and systematic evaluation.

In the field of HCI and intelligent system design, a large number of studies have been carried out around core technologies such as motion detection, action recognition, and data processing, aiming to improve the intelligence level and interactive experience of the system. Some studies use background modelling, inter-frame difference, Gaussian mixture model and other methods to extract moving targets and improve the detection accuracy in complex environments; other studies introduce Kalman filtering (Rossi et al,, 2021; Longo et al., 2022) and deep learning algorithms to achieve more stable and efficient motion tracking and behaviour analysis. In educational scenarios (Wang and Zhou, 2024; Sun et al, 2021), these technologies have been gradually applied to teaching evaluation, learning behaviour analysis, and personalised recommendation, promoting the data-driven and intelligent teaching process. On this basis, this paper combines the above technologies to construct an online sports teaching platform with real-time interaction and personalised feedback capabilities, and verifies its practical value in improving teaching effects through experiments, further expanding the application boundaries of intelligent multimedia technology in physical education.

## 3 Application of intelligent multimedia information technology in teaching platform

### *3.1 Service mode of learning platform*

Platform as a service (PaaS) is a running environment that provides services to users and deploys application software. In a multimedia computing infrastructure, PaaS ensures that the data and information required to run applications are available, and the cost varies according to the type and amount of data and information required by applications. In the eyes of application developers, PaaS is to integrate all data and information that can be shared on the network platform, and provide information according to user needs, so that designers can complete the task of developing applications through PaaS. Infrastructure as a service (IaaS) is an important element in the cloud platform design process, which is characterised by ensuring the interoperability of the system on the internet. The configuration information contained in IaaS includes network resources, hardware resources and bandwidth allocation.

### *3.2 System architecture analysis*

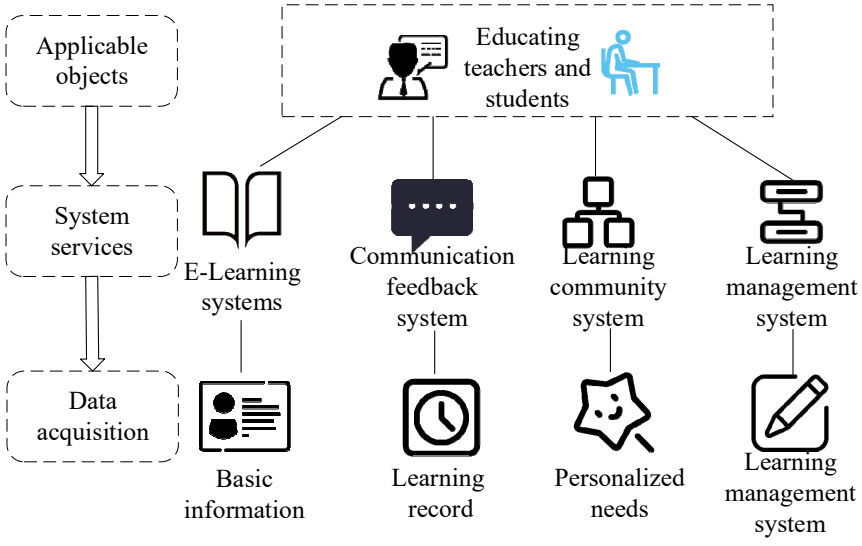
With the popularisation of multimedia technology online education platform model, many education platforms are trying to carry out online teaching, and finally determine the functional items on the basis of a detailed analysis of user needs. The different design concepts of each team lead to different characteristics of online education platforms at this stage, although most platforms still choose the B/S platform design mode.

### *3.3 HCI platform of the intelligent multimedia online teaching platform*

The platform is designed to meet the needs of teachers and students. Teachers and students are the target users of the platform, as shown in Figure 1. The e-learning system

includes courses, learning registers, self-assessment and learning archives. Learners can choose the sports courses they are interested in through course planning or active search. The communication and feedback system includes online discussion and Q&A. Learners can submit questions to teachers through self-study in advance, and teachers can answer learners' questions to teach. Students can choose to ask questions at the end of the lecture, mark them electronically and send them to the teacher, so that the teacher can receive confused questions in real-time. The community system includes learning groups, classroom discussions, etc. In the era of digital media, students can not only report their personal learning, but also have academic discussions with students. The teaching management system includes classroom management and progress tracking to help teachers plan teaching progress and monitor students' learning in the classroom.

**Figure 1** HCI platform of an intelligent multimedia online teaching platform (see online version for colours)




In addition to classroom management and progress tracking, the teaching management system also has functions such as data statistical analysis, personalised teaching recommendations, and teaching resource integration. It can improve teaching efficiency, optimise teacher-student interaction, help teachers accurately grasp students' learning status, adjust teaching strategies in a timely manner, and realise intelligent teaching management.

In the data collection stage, the sustainable development platform should at least include the following information: background information, learning records, personal needs and learning assessment. At the same time, users' listening time, examination results, keyword search and learning evaluation are important dimensions that should be recorded. By processing and analysing these huge datasets, the HCI platform can produce important research results, which can be effectively used to further develop the platform and optimise the experience (Ren and Bao, 2020; Xu, 2019).

## *3.4 The influence of intelligent multimedia information technology on physical education teaching*

### *3.4.1 Stimulating students' interest in learning*

Interest is the best teacher and the intellectual power to promote the search for knowledge and truth. Students' love of sports often starts from their interest. Only when students are interested in sports and often participate in them, can they develop the habit of perseverance and the awareness of lifelong fitness. Learning motivation is the most realistic and positive factor. People can quickly and stably understand what they learn when they are fully interested in it. As the carrier of learning information and the medium and carrier of transmitting information in the classroom, multimedia can not only be used to provide learning content, but also to integrate information technology into physical education, and create an environment to stimulate students' interest in learning.

Integrating information technology into physical education teaching refers to the application of intelligent means such as multimedia, network platforms, and big data in physical education classes, and improving teaching effectiveness, stimulating students' interest, and promoting personalised learning and teaching interaction through video demonstrations, motion capture, interactive feedback, and other forms.

### *3.4.2 Improving the effectiveness of teaching*

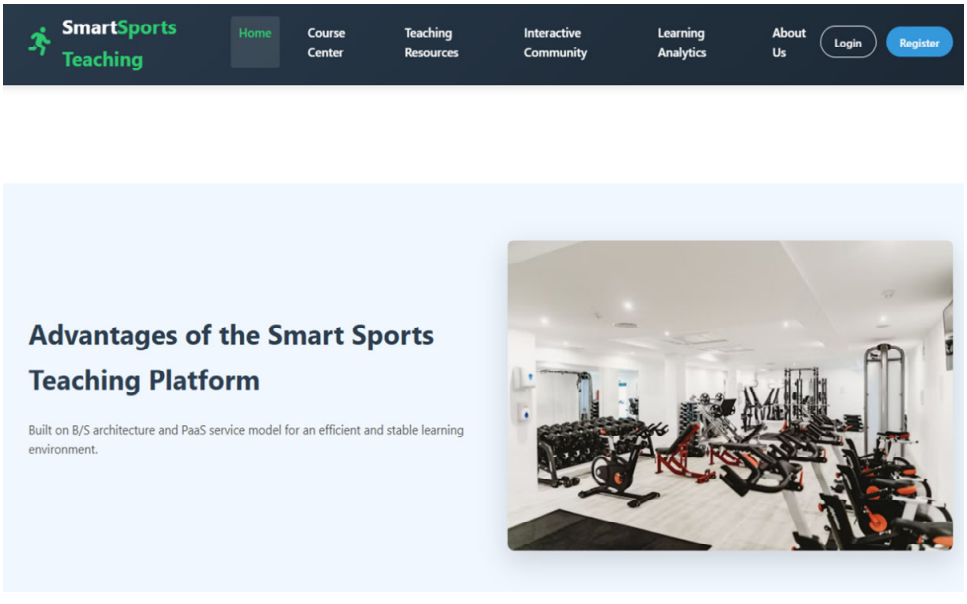
With the great changes in classroom teaching methods and the emergence of multimedia, multimedia courses have become an effective tool to improve teaching effects. Multimedia course is a new tool, which optimises the teaching process by using computer-based multimedia technology, on-site images, flexible animation and good music effects (El Saddik, 2018). Multimedia teaching materials are ready-to-use teaching materials closely related to the curriculum, which are designed and produced by teachers according to teaching needs. Using multimedia learning materials can easily solve important and difficult problems in teaching. During the teaching process, cartoons or pictures are used to illustrate the technical aspects that teachers cannot clearly show, or the aerial movements are stopped and shown to students, so that students can see all the technical details and understand the situation more quickly and in more detail. This enables students to better understand sports and shortens the generalisation process. This would help students quickly understand what they have learned and improve teaching efficiency.

### *3.4.3 Cultivating students' innovation ability*

In the teaching process, students imitate the relevant actions in the video, and then design other creative actions. This can not only exercise the muscles and joints of various parts of the body, but also improve the creative level of the brain. There is a clear and implicit goal combination. The use of real-time multimedia technology in physical education teaching can not only stimulate students' interest in learning, but also facilitate students' actions through real-time multimedia images. It also reduces teachers' demonstration, improves teaching efficiency, cultivates students' innovation ability, and improves students' application creativity.

**Figure 2** Sports network teaching system (see online version for colours)


**Figure 3** Platform advantages (see online version for colours)




In the teaching process, the rational use of multimedia learning materials can effectively break through the key and difficult problems that are difficult to present intuitively in traditional teaching. Through animation demonstrations, video explanations, image displays and other forms, abstract knowledge becomes more specific and vivid, helping students to better understand and master key knowledge points. Especially in physical education teaching, the details of technical movements are often difficult to fully convey through verbal descriptions or on-site demonstrations, while multimedia technology can clearly show the decomposition process of movements, enhance students' visual perception and movement memory, and thus improve learning efficiency. Therefore,

explaining and highlighting the key points and difficulties in teaching, and combining multimedia means for auxiliary teaching, can not only improve the quality of teaching, but also help stimulate students' interest and initiative in learning.

The sports network teaching system is shown in Figure 2.

The platform advantages are shown in Figure 3.

## 4 Mathematical model of HCI

### *4.1 HCI technology*

HCI refers to the information exchange between people and computers with specific language and methods under the support of certain interaction technologies to achieve mutual understanding (Shilton, 2018). It can improve the efficiency of human work and meet the needs of human life.

### *4.2 Motion detection*

The result of motion perception is to extract the motion regions in the foreground. However, if the background of human motion is very complex, the motion of objects in the background other than the human body must be considered. The purpose of moving object classification is to recognise others among moving objects. Only by correctly recognising the human body, can people track the human motion and understand the subsequent human behaviour, so the classification of moving objects is crucial. The main method to classify moving objects is based on human and motion features. This determines whether there is human movement in a moving object. If the state of an object at time $t$ is $Q(t)$, then there is a constant $p$:

$$Q(t+p) = Q(t) + S(t) \tag{1}$$

Among them, $S(t)$ is the displacement, and then the minimum time interval $p$ is the motion period of the object. With the central axis of the human body as the coordinate axis, the posture symmetry of the human body in the process of uniform motion would change periodically. This attribute can be used to build a self-evaluation matrix in the time domain. The periodic motion of the human body reflects different characteristics from other objects. This time-domain frequency method can be used to detect human motion.

The purpose of motion perception is to extract the moving area in the foreground in order to accurately identify human activities. This is because in a video sequence, the foreground usually represents the target object, and its motion characteristics are crucial for behaviour recognition and subsequent analysis. Extracting the foreground area can effectively remove background interference, improve the system's detection accuracy and stability of target motion in complex environments, and ensure the accuracy of subsequent tracking and recognition.

### *4.3 Motion tracking*

In the process of feature tracking, when feature points are lost due to the scattering effect or excessive change of motion, a filtering method is used to predict the position of feature

points as a supplement to feature tracking and as a correction for subsequent tracking. The Kalman filter is a recursive linear minimum error estimator, which has the advantages of fast and accurate estimation.

In digital signal processing, the function of a filter is to extract useful signals from noise. The differential model of the signal is:

$$m(y) = s(y) + v(y) \tag{2}$$

Among them, $m(y)$ the input signal $s(y)$ is the useful signal $v(y)$, and the noise. If the unit response of the filter is $n(y)$, the output is:

$$n(y) = \sum_{y} h(x)m(y-x) \tag{3}$$

The convolution form of the formula can be interpreted as the estimation of the current value $s(y)$ of the utility signal based on the current and past observation results $m(y)$, $m(y-1)$, $m(y-2)\ldots\ m(y-x)$. Therefore, the problem of filtering with filters can be regarded as an estimation problem.

### *4.4 Discrete Kalman filter*

The Kalman filter is an efficient recursive linear minimum error estimator with the advantages of fast calculation speed, high accuracy, and strong real-time performance. It can accurately estimate the system state from noisy data, is suitable for motion tracking and data optimisation in dynamic environments, and has wide application value in HCI, intelligent teaching platforms and other fields.

$$M_k = \Phi_{k,k-1}M_{k-1} + \Gamma_{k-1}W_{k-1} \tag{4}$$

The measurement formula of the $M$-dimension observation system is:

$$Z_k = H_k M_k + V_k \tag{5}$$

$M_{k-1}$ is the state vector of the system at time $k-1$, and $M_k$ is the state vector of the system at time $k$.

Since all image sequences to be concerned have fixed or basically fixed backgrounds, background subtraction can be applied to motion detection, which is not only simple in calculation, but also very efficient.

There are many methods to establish the background model. For example, the background image sequence without foreground motion can be used to estimate the parameters of the background model. The average value of the previous image sequence at the current time is used as the background image.

There are many ways to build a background model, and common methods include the frame difference method, the Gaussian mixture model, the median filter method, etc. Among them, using an image sequence without foreground motion to build a background model can reduce noise interference and improve the accuracy and stability of background extraction by calculating the pixel mean or median of multiple static frames.

The background image of $t = y$ time is:

$$B(m, n, y) = \frac{1}{X} \sum_{t=y-1-X}^{y-1} B(m, n, t) \qquad y-1-X >= 0 \tag{6}$$

Among them, $B(m, n, t)$ represents the background model value at the $(m, n)$ pixel at time $t$, and $y - 1 - X >= 0$ represents the calculation result at the initial time. To facilitate calculation, formula (6) can be rewritten as follows:

$$B(m, n, y) = B(m, n, y-1) + \frac{1}{X}(B(m, n, y-1) - B(m, n, y-X-2) \tag{7}$$

## 5 Influence of intelligent multimedia information technology on online sports teaching

Intelligent multimedia technology was applied to online sports teaching to build a HCI platform. This paper probed into the influence of intelligent multimedia technology on online sports teaching. Four classes were randomly selected for the experimental test, which were class 1, class 2, class 3 and class 4. Among them, class 1 and class 2 adopted traditional teaching methods for physical education, and class 3 and class 4 adopted online physical education teaching methods based on intelligent multimedia technology. The teaching time was 5 months, and the experimental results were counted every month. Students' enthusiasm test, students' examination results test, teachers' satisfaction test and students' satisfaction test were conducted for four classes. This paper observed the discrepancies in the results of four classroom tests and analysed the impact of intelligent multimedia technology on classroom physical education. The specific data of the four classes are shown in Table 1.

**Table 1** Class-specific data

| | *Class size* | *Average age* | *Ratio of men and women* |
|---|---|---|---|
| 1 Class | 58 | 20 | 1:1 |
| 2 Class | 60 | 20 | 2:3 |
| 3 Class | 62 | 19 | 1:1 |
| 4 Class | 60 | 20 | 3:2 |

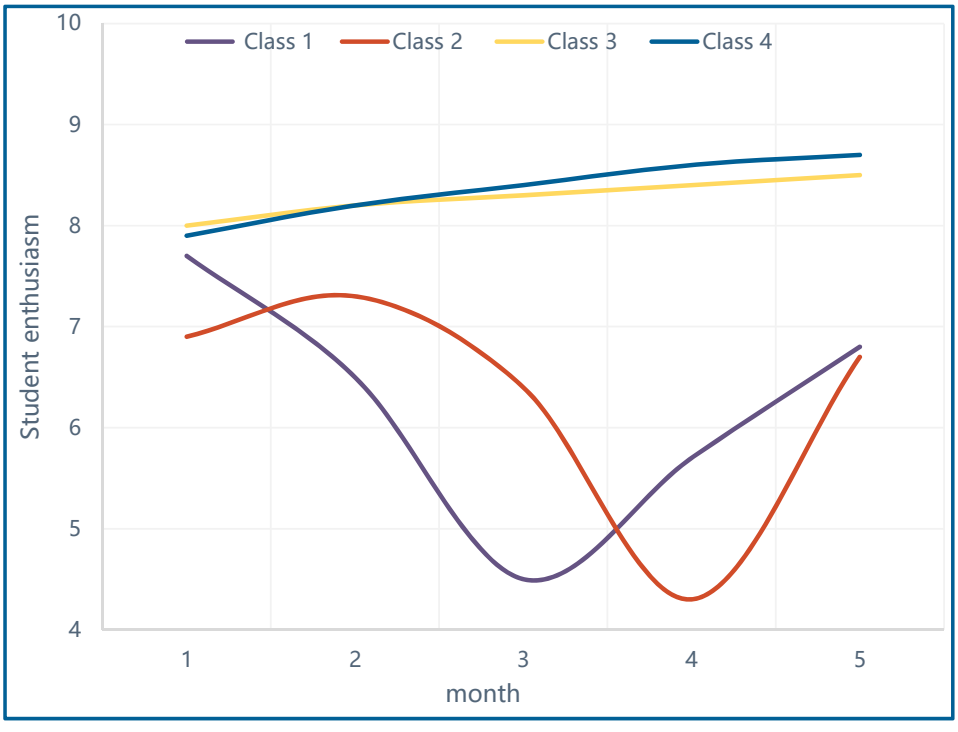
### *5.1 Student motivation test*

The more enthusiastic the students are, the better the level of interaction with the teacher, which can better ensure that students acquire knowledge. Students' enthusiasm was tested in four classes to observe the differences in students' enthusiasm for physical education courses in different classes. The experimental results were recorded and analysed. The specific results are shown in Figure 4.

As seen in Figure 4, the enthusiasm of students in classes 1 and 2 fluctuated greatly, while that of students in classes 3 and 4 fluctuated slightly. Class 1 showed a downward trend in the first three months and an upward trend in the last two months. Class 2 showed an upward trend in the first two months, a downward trend in the third and fourth months, and an upward trend in the last month. The enthusiasm of students in class 3 and

class 4 showed an upward trend, with the enthusiasm of students in class 3 rising from 8 to 8.5 and that of students in class 4 rising from 7.9 to 8.7. To sum up, the HCI design of intelligent multimedia technology can improve the enthusiasm of online sports teaching students.

**Figure 4** Student motivation test (see online version for colours)



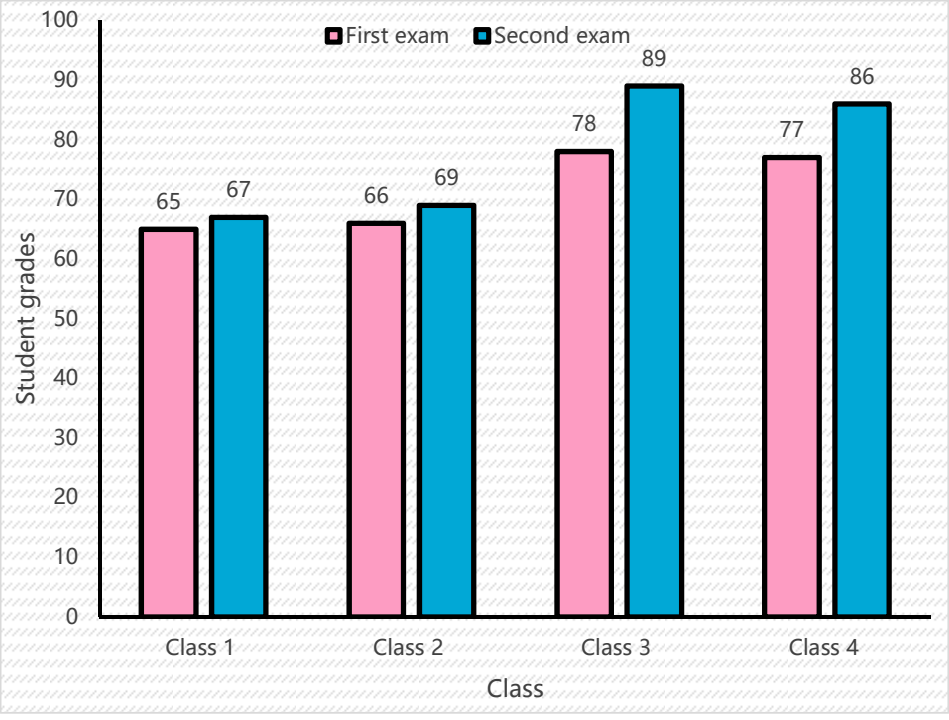

## *5.2 Student test results*

The students' test scores represent their mastery of the curriculum. The higher the students' test scores are, the better the teaching quality of the curriculum is, and the better the students' knowledge is mastered. The students in four classes were tested on their test scores. A total of two test scores were conducted to observe the differences in the test scores of the four classes. The experimental results were recorded and analysed. The specific results are shown in Figure 5.

As can be seen in Figure 5, students in classes 3 and 4 scored significantly higher than those in classes 1 and 2, and the students' scores of the four classes showed an upward trend. Among them, the scores of students in class 1 rose from 65 to 67; the scores of students in class 2 rose from 66 to 69; the scores of students in class 3 rose from 78 to 89; the scores of students in class 4 rose from 77 to 86. To sum up, the students in class 3 and class 4 scored higher than the students in class 1 and class 2 in the first exam, and the students' scores in class 3 and class 4 also improved much faster than those in

class 1 and class 2. Intelligent multimedia information technology can effectively improve students' learning performance on the online sports teaching platform.

**Figure 5** Student test scores (see online version for colours)

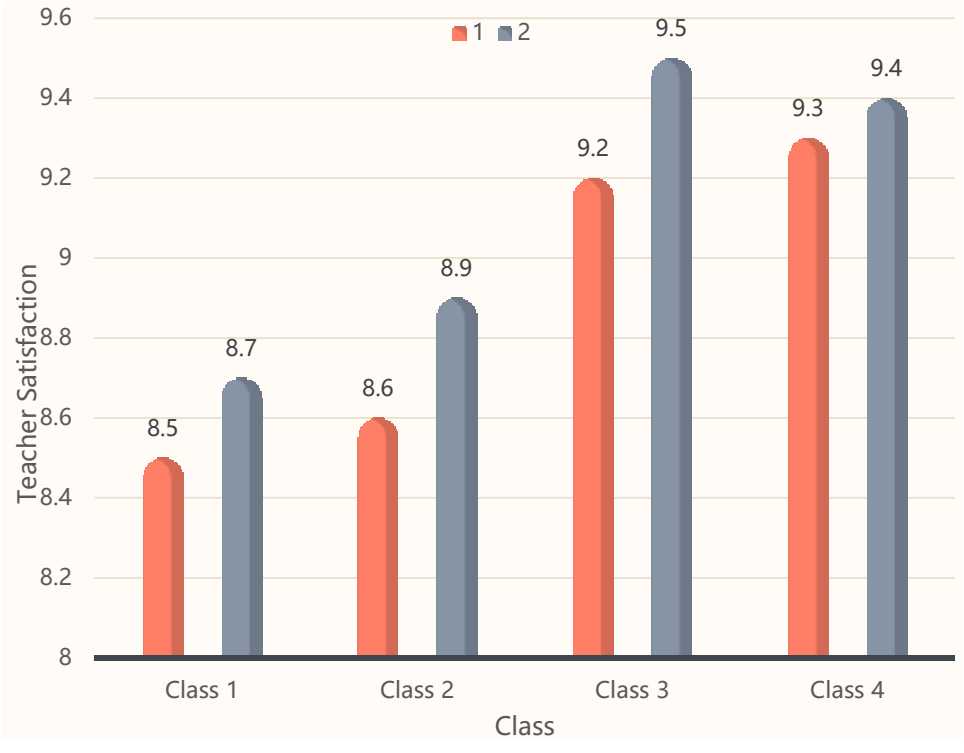



## *5.3 Teacher satisfaction test*

The satisfaction of teachers determines the enthusiasm of teachers in class, thus affecting the quality of the class. The higher the teachers' satisfaction is, the more they approve of the teaching methods, and the more they can make the most of their role as teachers in the classroom. Two teachers were randomly selected from four classes, and the teachers in four classes were tested for satisfaction to observe how satisfied the teachers in different classes were with different teaching methods. The results were recorded and analysed, as shown in Figure 6.

As can be seen from Figure 6, teachers in classes 3 and 4 were significantly more satisfied than those in classes 1 and 2. On the whole, it can be seen that this is true for both traditional physical education methods and online physical education methods that use intelligent multimedia information technology, and the overall teacher satisfaction of the four classes was very high. However, the teacher satisfaction of class 3 and class 4 was above nine points, far higher than that of class 1 and class 2. To sum up, the online sports teaching method using intelligent multimedia information technology can improve teachers' satisfaction.

**Figure 6** Teacher satisfaction test (see online version for colours)

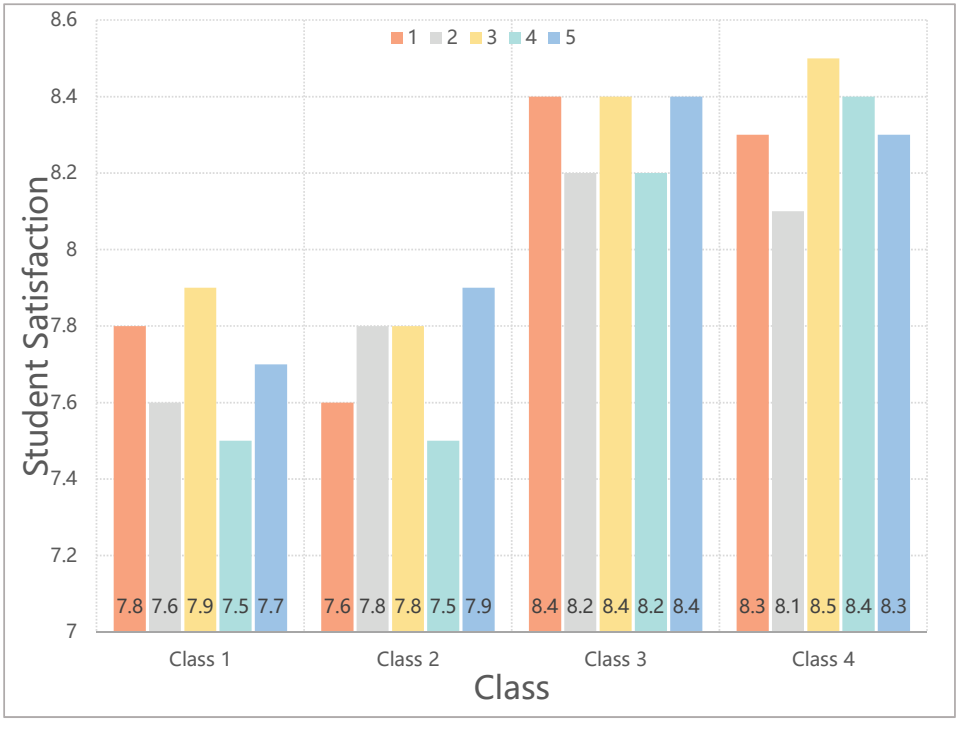



## *5.4 Student satisfaction test*

The higher the satisfaction of students with classroom learning, the more they can ensure their enthusiasm in class, thus ensuring the interaction between teachers and students, and improving the quality of physical education teaching. Five students in each class were selected for the satisfaction rating test to observe the difference in the teaching satisfaction rating of students in different classes. The experimental results were recorded and analysed. The specific results are shown in Figure 7.

As can be seen from Figure 7, students in classes 3 and 4 were significantly more satisfied than those in classes 1 and 2. Among them, the student satisfaction of class 1 and class 2 was between 7.5 and 8.0, and that of class 3 and class 4 was between 8.0 and 8.5. Among them, the average satisfaction score of students in class 1 was 7.7; the average satisfaction score of students in class 2 was 7.72; the average satisfaction score of students in class 3 was 8.32; the average satisfaction score of students in class 4 was 8.32. To sum up, the average satisfaction score of the students in the class with the traditional sports teaching method was 7.71, and the average satisfaction score of the students in the class with the online sports teaching method using intelligent multimedia information technology was 8.32. HCI design with intelligent multimedia technology can help enhance the satisfaction of online physical education students, and the satisfaction has increased by 7.9%.

**Figure 7** Student satisfaction test (see online version for colours)




## 6 Conclusions

Along with the continuous advancement of information technology, online teaching has gradually appears in people's vision. Web-based teaching is a more innovative teaching method compared with traditional teaching methods. For example, in physical education, the application of intelligent multimedia technology makes students no longer limited to obtaining knowledge from teachers, and HCI technology makes students the main body of the classroom. The HCI design of intelligent multimedia information technology in online sports teaching platforms can improve students' enthusiasm in class, so as to improve students' performance. The novel online teaching method is more satisfactory to teachers and students. Although this study verified the effectiveness of intelligent multimedia technology in physical education teaching, the sample range was limited, lacked long-term tracking data, and had insufficient adaptability analysis for different age groups and individual differences, which affected the wide generalisability of the results.

## Declarations

The authors declare no conflict of interest.

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