



Analysis of the Effect of Multiple Integration of Teaching Methods in University Physical Education on the Improvement of Students' Comprehensive Physical Quality

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SUMMARY: *The article describes the teaching methods used by physical education teachers in the classroom setting and explores how observational learning, contextual learning, and flipped-classroom teaching methods interact in university physical education classes. It develops a multidimensional model of the application of various teaching methods in the field of university physical education. The MonoLoco method is utilized to attain the fuzzy localization process, and the information fusion method is utilized to improve human body posture data. Further, the HRNet model is introduced to include de-redundancy design and multi-resolution supervision to develop a keypoint detection algorithm for human skeletons based on the DHRNet network. By combining the monocular human-positioning algorithms with the DHRNet model to detect skeletal keypoints, the integrated physical fitness evaluation model for students is generated. The model is used to assess the performance of physical education teaching methods from a multidisciplinary perspective. The experimental results of integrating several teaching methods showed that the experimental group had improved their comprehensive evaluation index, including 50 meters, 1000 meters, standing long jumps, and shot put. The mean values of the 50 meters time reduced by 0.222 s, 1000 meters increased by 0.274 points, standing long jumps increased by 0.295 m, and shot put increased by 0.386 m. The above results indicate that the effectiveness of the physical education teaching with multiple teaching methods is considerable and applicable in university-level physical education.*

KEYWORDS: *monocular body localization; DHRNet network; key point detection; multiple teaching methods; comprehensive physical fitness*

1 Introduction

In the modern education concept, university sports is not only a field for physical exercise and skill development, but also an important platform for promoting the improvement of students' comprehensive physical quality [1]. The connotation of comprehensive physical quality has multi-dimensional embodiment in the university. The first is the improvement of physical health and athletic ability, including the steady progress of cardiorespiratory function, muscle strength,

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flexibility, coordination and motor skills [2]. Literature [3] examined the effects of physical activity on students' athletic ability, and through an experimental test for 12 weeks, revealed that the combination of physical activity, especially aerobic exercise and strength training, plays an important role in enhancing students' athletic ability. Secondly, the cognitive dimension of development, physical activity enhances concentration [4], working memory and problem solving skills, and even has a positive impact on motivation and academic performance. Literature [5] emphasizes the importance of physical education in the development of concentration, such as the use of bow and arrow shooting as a means of physical education and physical training, which helps to train students to focus their minds and sight, thus improving concentration. Again, the development of emotional and psychological qualities [6], stress coping, emotional adjustment, frustration tolerance and self-efficacy in sports can be gradually built up during participation. Literature [7] and literature [8] discussed the impact of physical education on the enhancement of college students in terms of mental health qualities, which was confirmed by the study and emphasized that the correct use of physical education in the guidance of students in terms of mental health can effectively improve the teaching and learning. Finally, it is the development of social literacy, such as cooperation, communication [9], respect for rules, fair play and leadership. Literature [10] analyzed the impact of physical education and sports on the development of students' communication skills, and the findings showed that physical education and sports are crucial for improving students' communication skills, especially for medical students, whose communication skills will affect their career. The multiple integration of physical education teaching methods is an important way to realize the improvement of students' comprehensive physical quality and promote their overall development.

Multiple integration of teaching methods is a comprehensive teaching method that combines traditional teaching methods with innovative teaching methods under the background of educational informatization, such as personalized teaching, interactive and interactive teaching, multimedia teaching, which is of great significance to improve the effect of students' comprehensive physical quality in university physical education teaching [11, 12]. The multiple integration method focuses on the comprehensive development of students' physical quality, including strength, speed, sensitivity, flexibility, etc. Teachers can set up a variety of sports programs and training content to cultivate different aspects of students' physical quality [13-15]. The multiple integration method also focuses on individualized cultivation of students' physical quality. Because the physical quality of each student varies greatly, teachers should set up different sports programs and training contents according to the differences in students' physical quality to meet the needs of each student's physical quality cultivation, so that each student can find a suitable sports program for himself or herself and devIn recent times, as the levels of physical fitness indicators of students have deteriorated yearly, more scholarly interest has been drawn to enhance the comprehensive physical fitness of students by utilizing diverse methods of teaching physical education in universities. Specifically, previous literature [21] note that conventional techniques of physical education ignore personal differences of students which limits their physical abilities from developing effectively. They present a technique of physical education that focuses on personalization and multi-integration which considers personal differences of students for enhancing physical fitness. Similarly, another Literature [22] highlights the integration and innovation of physical education using diverse methods, noting that diverse methods take advantage of the benefits of different modes of teaching while reducing the weaknesses associated with individual ones which results in enhanced physical fitness. Finally, another Literature [23] emphasizes the use of intelligent physical education teaching platforms for promoting physical education. They indicate that by employing diversified teaching strategies on an intelligent platform in the age of reform in education,

physical education becomes more interactive. Literature [24] explain the current composition and limitations associated with the university PE curriculum and offer a model of diversified systems construction based on optimizing curriculum content, implementing innovative teaching techniques, and changing assessment techniques. It should be noted that diverse and comprehensive composition of curriculum content has a great influence on enhancing interest in PE among students and improves students' physical health condition. Literature [25] focus on PE contribution to physical, psychological, and social development of students. The authors note that PE improves comprehensive physical fitness level among students due to the application of diversified and individualized instructional techniques as well as innovative teaching techniques. Literature [26] introduces APE methodology and its significance. Authors indicate that student groups are heterogeneous and include individuals with different preferences and needs, so the use of APE contributes to acquiring comprehensive body of knowledge, including implementation of diverse and personalized teaching technique. Literature [27] underlines the importance of diversified and integrated teaching of PE techniques and discusses the creation of a PE video teaching technique that integrates classical and modern teaching techniques and allows adjusting teaching methodology based on individualized needs of each student.

The study explores the use of several methods of teaching physical activities in college by creating a model that combines the offline and online models. The research considers the integration of three major models such as the observational method, contextual learning, and flipped classroom approach in the evolution of college sports pedagogy. Additionally, it contributes to the development of human body pose estimation through designing a new monocular approach based on the principle of information fusion and improves the computational parameters of the HRNet structure, thereby proposing a new DHRNet structure. This DHRNet structure is utilized for the detection of key joints of the skeletal human structure, and then a complex model for evaluating students' overall physical fitness is proposed. The multi-method approach is tested with the help of the experimental group, allowing the comparison of improvement of comprehensive physical fitness in both groups.

2 Practical Strategies for Integrating Multiple Teaching Methods in University Physical Education Subjects

2.1 Modeling the construction of multiple teaching methods in physical education

Diversified teaching methods adopt the mode of fusion of Internet teaching and offline teaching, playing the advantages of traditional teaching methods and Internet teaching, focusing on the guiding role of the teacher in teaching, but also focusing on the initiative of students' learning, stimulating the creativity of students' learning, and encouraging students to show their individual talents in learning.

Modern information technology development speed, the use of Internet technology to build online network classroom, change the traditional teaching methods, online classroom and traditional classroom integration to form an organic mixture, enhance the relevance of teaching, improve the learning effect of students.

The teaching process of multiple teaching methods is similar to the teaching process of traditional teaching, including various stages such as lesson preparation and evaluation. Multiple teaching methods need all kinds of teaching resources in the traditional classroom, but also need the Internet online teaching resources. Evaluation of teaching results should not only

evaluate the process of teaching, but also summarize the effect of teaching. Multiple teaching needs to set teaching themes and teaching objectives, choose appropriate teaching content, and combine the characteristics of multiple teaching, the online and offline multiple teaching method construction model is shown in Figure 1.

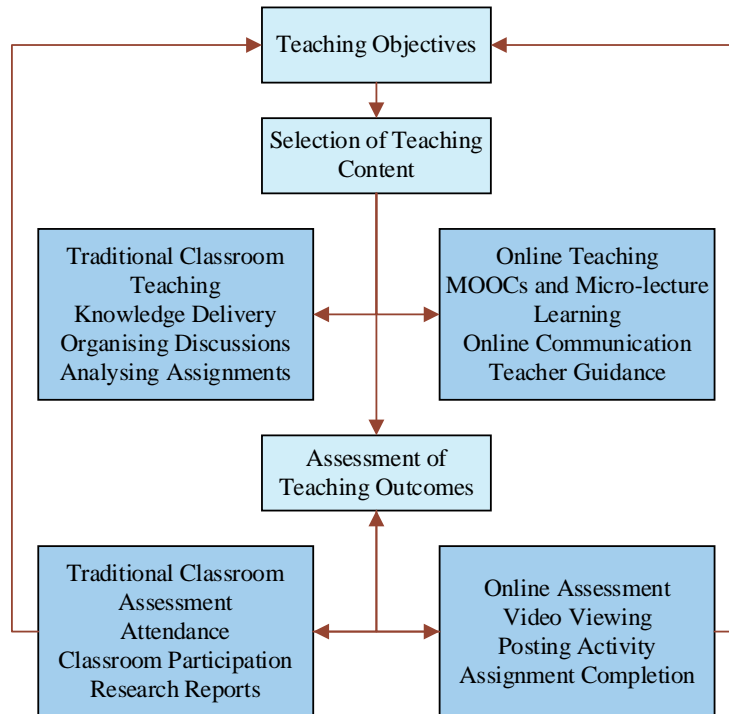


Figure 1: The online and offline multi-teaching method builds the model

2.2 Interactive practice development of diverse teaching methods

Under the physical education and health curriculum standard, a single teaching method cannot meet the students' needs for physical education classroom, and it is easy for students to produce tedious and boring emotional experience, and cannot stimulate students' interest in independent learning.

It is found that physical education teachers commonly apply the lecture method and demonstration method in the classroom, and reasonably combine and interact with the observation teaching method, contextual teaching method, and flipped classroom teaching method on the basis of the lecture method and demonstration method, which are two generally applicable teaching methods.

2.2.1 Observational teaching methods

Observational teaching method refers to the method in which students, under the guidance of physical education teachers, fully mobilize their subjective initiative to comprehend the main points of technical movements, the laws and principles of movement formation through observation and experience.

Observational teaching method in the physical education classroom interacts with lecture method and demonstration method to achieve better teaching effect. In a physical education course, when the physical education teacher introduces the learning content of the class, he or she can appropriately use a series of photographs, videos and other visual sensory teaching aids to show the students the sports skills or technical movements to be learned in the class, which can enable the students to form the standard technical movement postures in their thinking and

have the motivation to imitate toward the visual images.

2.2.2 Contextualized pedagogy

With the development of science and technology, the contextual teaching method will be applied more in physical education, and the reference of virtual reality technology such as AR and VR relying on “Internet +” provides the digital informatization conditions for the realization of virtual teaching method.

AR, VR and other virtual reality teaching courses can strengthen the interactivity of students and physical education teachers, without the influence of space and time, even if the remote operation can also be successfully completed, which also provides new ideas for the future of new physical education teaching methods.

2.2.3 Flipped classroom teaching methodology

With the wide application and development of multimedia technology, the flipped classroom teaching method can be tried in physical education courses, taking SPOC and MOOC as the form carrier, integrating high-quality teaching resources from different channels all over the world, and establishing the relationship between students' independent online learning and teachers' face-to-face learning.

The improvement of physical education teachers' comprehensive quality ability is the key to realizing the interaction of multiple teaching methods. Teachers are deeply committed to improving their teaching ability, studying the physical education and health curriculum standards, and cultivating the professionalism of “multi-talented” physical education. They also take the initiative to master modern teaching methods and realize diversified physical education teaching methods with scientific methods, reasonable forms, efficient organization and innovative contents.

3 Modeling of a comprehensive assessment of the effectiveness of diversified teaching in sports

3.1 Monocular human localization method based on information fusion

This paper proposes a monocular human localization method based on information fusion to get more accurate human body position through information fusion, and also to provide support for human body localization for the design of students' comprehensive physical fitness assessment model.

The aim of this paper is to get the accurate position information of human body through monocular image, for this reason, this paper proposes a monocular human body localization method based on information fusion.

3.1.1 Design of fuzzy information generation module

This part mainly introduces two modules for generating fuzzy information: fuzzy localization information generation module and auxiliary depth information generation module.

In this paper, fuzzy localization information is obtained by the MonoLoco method, which firstly uses the PifPaf human skeleton point detection method to obtain the human skeleton information, and then obtains the relative distance between the human body and the camera by using the camera's internal reference and the triangular similarity theorem.

The MonoLoco method takes the human skeleton information and quantifies the uncertainty through a lightweight feed-forward neural network to obtain uncertainty confidence intervals

for the human body. The model output is assumed to be a Laplace distribution, and the use of a Laplace distribution instead of a Gaussian distribution allows for insensitivity to the proximity of the predicted object distance during the computation process, capturing the uncertainty through a probability distribution on the model output. The relative Laplace loss can be defined based on the negative log-likelihood of the Laplace distribution, as shown in Equation (1), where μ and b are the parameters of the model prediction, μ denotes the true distance, b denotes the distribution, and the confidence interval is $\mu \pm b$, i.e.:

$$L_{Laplace}(x|\mu, b) = \frac{|1 - \mu/b|}{b} + \log(2b) \quad (1)$$

The auxiliary information generation module mainly generates two parts of information, namely the pseudo-radar point cloud with human body information and the bird's eye view with human body depth information.

Given the depth estimation image and the camera parameter matrix, the 3D position of each pixel $[u, v]$ in the camera coordinates (X, Y, Z) can be computed, and the transformation formula is as in Eq. (2), i.e:

$$\begin{aligned} X &= \frac{(u - c_x)Z}{f_x} \\ Y &= \frac{(v - c_y)Z}{f_y} \end{aligned} \quad (2)$$

where f_x, f_y represents the focal length on the horizontal and vertical axes, c_x, c_y represents the coordinates of the pixel center position, and Z represents the depth distance obtained by the depth estimation method.

Through the above method, the semantic segmentation map with human body information can be transformed into a pseudo-radar point cloud with human body information, and the bird's-eye view map with human body depth information can be obtained by vertically projecting the pseudo-radar point cloud.

3.1.2 Information fusion module design

In this paper, information fusion is used to refine the human body position.

(1) Refined localization based on bird's-eye view view

In the first step, this paper fuses the uncertainty confidence interval of the human body obtained from the fuzzy information generation module and the bird's-eye view information with the depth information of the human body to obtain the region of interest in the bird's-eye view.

In the second step, in this paper, in order to reduce the influence of the long-tail effect, the sparse points in the intercepted bird's-eye view map can be easily found to be the mapping of those long-tail points.

In the third step, this method inflates the resultant map obtained in the second step, and then performs the computation of connected regions once more, and the maximum connected regions are filtered.

The expansion operation can be expressed as equation (3), where src represents the input image, dst represents the output image, and $kernel$ represents the selected kernel size. i.e:

$$dst(x, y) = \max_{((x', y') \text{ in kernel})} src(x + x', y + y') \quad (3)$$

(2) Corrected localization based on K-means aggregation

According to the nature of the pseudo-radar point cloud, this paper uses the K-means method to locate the final position of the human body within the refined pseudo-radar region. The specific steps of the K-means aggregation method are as follows:

Assume a set of data as $D = \{x_1, x_2, \dots, x_m\}$, where x_1, x_2, \dots, x_m are all real vectors of the same dimension, let the initial center of mass be $U = \{u_1, u_2, \dots, u_k\}$.

In the first step, the sample x_j ($1 \leq j \leq m$) is selected, and then the distance d_{ji} between x_j and the initial center of mass u_i ($1 \leq i \leq k$) is computed as shown in Eqn. (4), and then the distance between the sample x_j and each of the center of mass u_i with the smallest distance λ_j , as shown in Equation (5), after which the sample x_j is classified into different cluster groups by λ_j , as in Equation (6):

$$d_{ji} = \|x_j - u_i\|^2 \quad (4)$$

$$\lambda_j = \arg \min_{i \in \{1, 2, \dots, k\}} d_{ji} \quad (5)$$

$$C_{\lambda_j} = C_{\lambda_j} \cup \{x_j\} \quad (6)$$

In the second step, the new center of mass of each cluster is calculated as shown in Eq. (7):

$$u'_i = \frac{1}{C_i} \sum_{x \in C_i} x \quad (7)$$

Repeat the operation of the first two steps until the $u'_i = u_i$ loop stops.

According to the bird's-eye view based refinement localization method to get the refined position, this paper will project the refined position on the pseudo-radar point cloud to get the refined pseudo-radar point cloud.

3.2 Lightweight human skeletal keypoint detection network

In order to improve the performance of human skeletal key point detection, the high resolution network (HRNet) is proposed, but while the network improves the detection accuracy, its computational and parametric quantities increase accordingly, which is not favorable to the actual project. In this paper, we aim to reduce the computation and parameter count of the network under the condition of guaranteeing the detection accuracy, and propose the skeletal key point detection technology based on DHRNet network, which also provides the support of human skeletal key point detection for the realization of the students' comprehensive physical fitness assessment model.

3.2.1 HRNet network model

HRNet network constructs the series structure between different resolution feature maps into a parallel structure, and continuously performs feature fusion between different resolutions on its

basis. Due to the balance between the detail information of high-resolution features and the semantic information of low-resolution features, the HRNet network achieves good results in the classification task.

The process of skeletal keypoint detection based on this network: the image is input to the HRNet network for feature extraction, and the output of the network is the position coordinates of the skeletal keypoints.

3.2.2 Improved DHRNet network models

The HRNet network is categorized into HRNet-W32 branches and HRNet-W48 branches based on the difference in the number of channels in the last three stages of the branch with the highest resolution. In this chapter, the research is carried out based on the HRNet-W32 network model.

First, for the problem of excess computation on networks and inefficiency, the de-redundant approach is adopted to generate a lighter model for detecting objects while maintaining the detection accuracy as much as possible. Second, to overcome the problem of accuracy reduction due to the de-redundant approach and increase the accuracy for detecting small targets, the DHRNet model is built based on the de-redundant approach. The architecture of DHRNet is illustrated in Figure 2 below, where the red box shows the improved part.

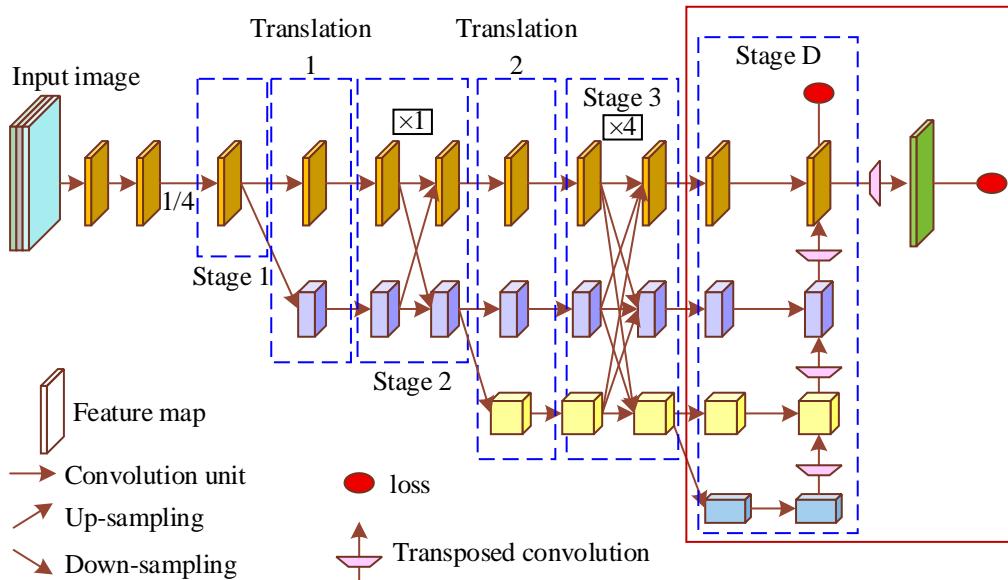


Figure 2: DHRNet network model

The HRNet-W32-St3 network has high utility, but combining the different stages of the HRNet-W32 network shows that the HRNet-W32-St3 network is missing the sub-network of the lowest resolution branch compared to the original network, resulting in the loss of information at that scale, and also missing the four-layer multiscale feature fusion layer at the fourth stage of the network, which ultimately leads to its Both feature extraction and multiscale feature fusion are limited, and the performance is slightly degraded compared with the original network. Therefore, in this paper, the multiscale feature supplementation and intermingling module (Stage D) is added to HRNet-W32-St3 to ensure the efficiency of the model while improving the detection accuracy. In this paper, the way of recovering high resolution in Stage D is replaced by transposed convolution from the original nearest neighbor interpolation upsampling operation.

There are some problems encountered in the process of skeleton keypoint extraction on small objects. First of all, the accurate detection of keypoints for further away objects requires

dealing with the problem of scale change, while the quality of heatmaps, specifically their resolution, is important for detecting keypoints of small objects. Thus, to achieve high-resolution heatmaps for the exact detection of keypoints of small objects, the current part of the study makes use of Stage D's multi-scale feature complementation and intermingling module. Using the technique of transposed convolution, a high-resolution feature map is obtained that can be used together with the feature maps from Stage D to obtain a high-resolution feature pyramid.

In order to account for different scales as well as increase the ability of the network to identify mistakes in learning, a multi-scale approach is utilized to calculate the loss function. In particular, the highest-scale branch from stage D as well as the high-scale branch that comes after transposed convolution are used to independently calculate the loss function for the estimated heatmap, and the overall heatmap loss equals their sum.

In StageD, the 1/4 resolution heatmap containing i keypoints is the learning target of the network, and the final 1/2 resolution heatmap is the learning target of the network after the transpose-convolution operation. A 2D Gaussian distribution function is used to generate the true heat map $h_i(x, y)$:

$$h_i(x, y) = \frac{1}{2\pi\sigma^2} \exp\left(\frac{-[(x-x_i)^2 + (y-y_i)^2]}{2\sigma^2}\right) \quad (8)$$

where (x, y) denotes the position coordinates of any pixel point in the real heat map, (x_i, y_i) is the center of the Gaussian function, which denotes the real position coordinates of the i th key point, and σ denotes the standard deviation of the Gaussian function predefined for each key point.

Accordingly, for each skeletal key point, the network also generates a predictive heat map from the 2D Gaussian function. Unlike the real heat map, the Gaussian function of the prediction heat map is centered at the predicted position (x_i^*, y_i^*) of the corresponding key point. The predictive heat map $h_i^*(x, y)$ is calculated by the following equation:

$$h_i^*(x, y) = \frac{1}{2\pi\sigma^2} \exp\left(\frac{-[(x-x_i^*)^2 + (y-y_i^*)^2]}{2\sigma^2}\right) \quad (9)$$

The loss function is categorized into two main types: classification loss and regression loss, and since the skeletal keypoint detection in this paper takes a heat map regression-based approach, the mean square error (MSE) loss function is used. Namely:

$$Loss = \frac{1}{N_b} \sum_b MSE(h_i^*(x, y), h_i(x, y)) \quad (10)$$

$$MSE(h_i^*(x, y), h_i(x, y)) = \frac{1}{wh} \sum_w \sum_h (h_{i(b)}^*(x, y) - h_{i(b)}(x, y))^2 \quad (11)$$

where N_b denotes the number of skeletal keypoints, $h_i(x, y)$ and $h_i^*(x, y)$ represent the true and predicted heatmaps for the i th keypoint, respectively, and w and h represent the width and height of the corresponding feature maps.

By denoting the highest resolution (1/4 resolution of the input) branch loss value in Stage D by $Loss_{1/4}$, and the higher resolution (1/2 resolution of the input) branch loss value after transposed convolution by $Loss_{1/2}$, the total loss value L of the final keypoint detection heat map is:

$$L = Loss_{1/4} + Loss_{1/2} \quad (12)$$

4 Comprehensive physical fitness assessment of students and analysis of the effects of improvement

4.1 Comprehensive physical fitness assessment model experiment and result analysis

The experiments were conducted using Tensorflow deep learning development platform, i7-5930K CPU, RTX2080 GPU, 16 GB video memory and Ubuntu 16.04 operating system. The resolution of the experimental input image is 192 pixels \times 192 pixels, and the input training image is randomly augmented with data using image processing strategies such as rotation, flipping, scaling, cropping, brightness adjustment, contrast adjustment and saturation adjustment. On this basis, the network model was iterated 100,000 times using Adam with a batch size of 16, an initial learning rate of 0.0003, and 95% of the previous learning rate decay per 10,000 iteration rounds.

4.1.1 Methodological evaluation indicators

Percentage of Correct Keypoints (PCK): Widely used in keypoint detection, the accuracy of detected keypoints is determined by measuring the distance between the location of the predicted keypoints and the location of the true keypoints. The higher the value of PCK, the better the performance of the model. The MPII dataset uses the length of the header as a normalized reference, i.e., PCK_h , which can be expressed as:

$$PCK_h = \frac{\sum_i \delta(d_i < kL_{head}) \delta(v_i > 0)}{\sum_i \delta(v_i > 0)} \quad (13)$$

where: i is the keypoint number. d_i is the Euclidean distance between the current detection of the i th keypoint and the i th keypoint in the true value, kL_{head} is the current head diameter of the person as a scale factor, where k is the number of keypoints, L_{head} is the diameter of the head, δ is Kronecker's function, v_i is the visibility of the i th keypoint.

4.1.2 Data sets

The algorithm in this paper is oriented to cell phone terminals to realize real-time human keypoint detection, which is different from the dense and small target characteristics under natural scene shooting, and the cell phone selfie video has a certain degree of purposefulness and specificity.

The experimental dataset consists of 23946 single human images from the AI Challenger dataset, of which 20000 images are randomly selected as training samples and 3000 as test samples. The labels are stored using Json format, and the labels store information about 14 joint

points of the target human body, including the head, neck, shoulder, elbow, wrist, hip, knee, and ankle.

The experiments evaluate the keypoint prediction accuracy using PCK_h in the keypoint PCK with head length as the normalized reference. The experimental results are all $PCK_h @0.5$ results, i.e., 50% of the head length is used as the matching threshold. The predicted location of each keypoint is the location of the maximum response point of the corresponding channel on the predicted thermogram.

4.1.3 Experimental results

(1) Multi-scale prediction experiment

The DHRNet algorithm uses a lightweight backbone network for feature extraction, and the multiscale prediction results are continuously refined on the feature maps of different resolutions to finally output the prediction results. In this paper, we experimentally study the effect of the prediction scale of the network model on the prediction accuracy of key points. The $PCK_h @0.5$ pairs of multi-scale network models are shown in Fig. 3, which reveals that the key point prediction accuracy of the three-scale network model is optimal on the whole, and that the key point prediction accuracy of the four-scale network model is the poorest on the whole. When the network model is a four-scale 32x downsampling, the DHRNet algorithm's $PCK_h @0.5$ for ankles is only 16.85%. The main reason is that the loss function on 32x downsampling reaches saturation when the value is large, which increases the difficulty of training on subsequent scales. Moreover, due to the relatively large error in the results obtained by 32-fold downsampling, it will affect the prediction performance of the subsequent network.

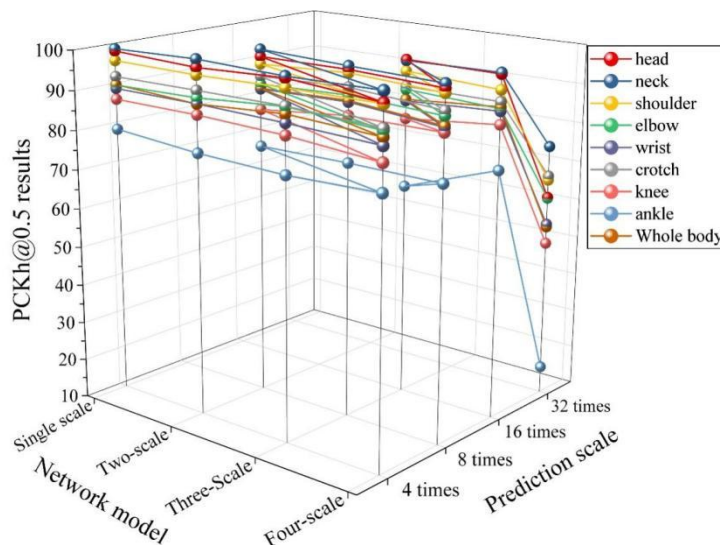


Figure 3: $PCK_h @0.5$ contrast of multi-scale network models

(2) Multi-scale prediction result fusion experiment

The $PCK_h @0.5$ pairs of multiscale prediction result fusion are shown in Figure 4.

The $PCK_h @0.5$ of head, neck, shoulder, elbow, wrist, hip, knee, ankle, and whole body after the multiscale prediction fusion is improved by 0.88%, 0.21%, 0.32%, 1.21%, 0.35%, 1.1%, 1.32%, 0.92%, and 1.22% compared with that of the 4-fold descending sampling, respectively.

For the DHRNet algorithm with three-scale prediction, the difference in detection performance between different scales is small, and in the prediction of keypoints at certain sites,

the low-scale prediction results are even better than those of the high-scaled detection structures, e.g., crotch on 8-fold downsampling is the optimal result among all scales. The crotch detection results on 4-fold, 8-fold, and 16-fold downsampling were 91.52%, 92.84%, and 90.55%, and the multiscale prediction result was 92.62%. Fusion of prediction results on different scales can effectively improve the prediction accuracy.

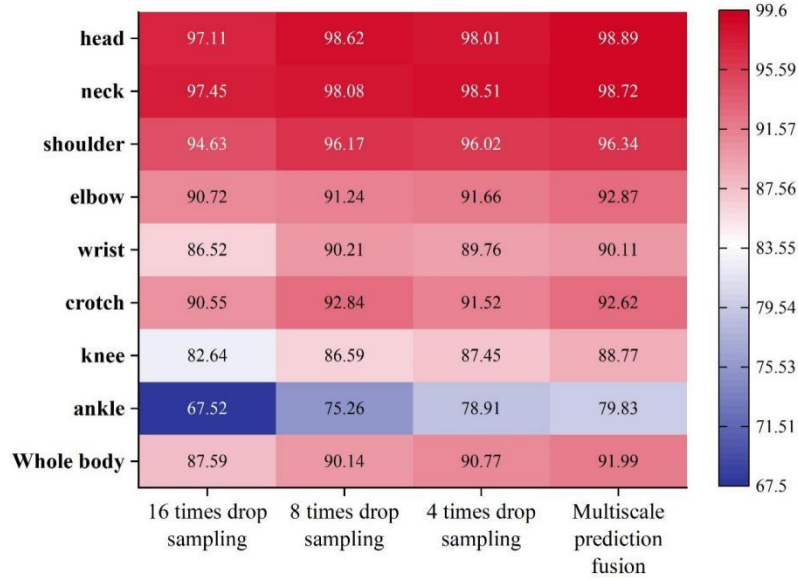


Figure 4: Comparison of $PCK_h @0.5$ with multi-scale prediction results

4.1.4 Validation on the dataset

The DHRNet model is validated against the human bone critical point detection models (CPMs), CPMs-Stage4 model, and HRNet model, in which CPMs-Stage4 shortens the training time and improves the detection speed by reducing the two prediction phases. Comparison of the validation results of the models trained on the MPII dataset is shown in Fig. 5. The accuracy of the DHRNet model is 13.62% higher than the HRNet algorithm, and the training time is 163.45 h less. The model proposed in this paper not only has the highest accuracy, but also has the least training time, i.e., the fastest detection speed.

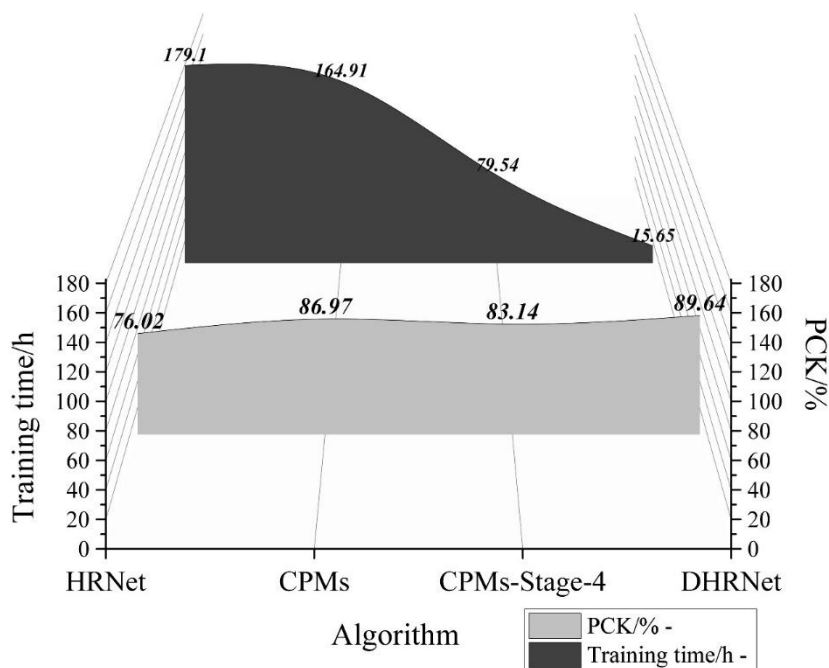


Figure 5: The results of the model of the MPII data set are compared

4.2 Analysis of the effectiveness of teaching methods

4.2.1 Design of teaching experiments

Through the teaching comparison experiment, to explore the application effect of the integration of multiple teaching methods of college physical education in the special class, so as to provide a reference for teachers to better teach sports technology.

This experiment adopts the single-blind experimental method, in the research process, only the researcher understands the experimental group and the control group setup, while the students only know that they are in the normal class, and are not aware of the existence of this experiment.

Sixty-two students from a sophomore sports-specific class in a city college were selected for this experiment. Because the 62 students in the sports-specific class of this university are from classes 1-6, and the teaching method is the same batch of classes 1-3 and the same batch of classes 4-6. Therefore, in this experiment, the students (30 students) from classes 1-3 of the physical education specialization class were set as the control group, and the students (32 students) from classes 4-6 of the physical education specialization class were set as the experimental group. Physical education in the control group was taught using traditional teaching methods and physical education in the experimental group was taught using multifaceted teaching methods. A total of 10 teaching weeks were conducted from April 14 to June 20, 2025, with experimental pre-tests and post-tests conducted before and after the teaching interventions, and lectures were given twice a week, with a class period of 80 minutes each time.

4.2.2 Results and analysis

In order to guarantee that the findings from the experiment were reliable and that any differences in the baseline conditions would not affect the findings, both groups of learners were compared and analyzed across the different measures before the experiment was conducted.

Before the experiment, the comprehensive physical fitness test model constructed in this research was used to test and record the two student groups. As shown in Figure 6, the comparative analysis of physical fitness test results of the two student groups is provided.

For the 50m running test, the average time for the experimental group and control group were 8.304s and 8.334s, respectively. Through the independent-samples t-test, the t-value was 0.124, and the P-value was 0.715, which was greater than the standard 0.05. Therefore, there is no significant difference between the two groups before the teaching intervention.

Similar to the 50m running test results, the independent-samples t-test results of the 1000m running, standing long jump, and solid ball throwing tests also show no significant difference between the two groups. It can be seen that the two student groups had equal physical fitness before the experiment, meeting the prerequisites of the teaching experiment.

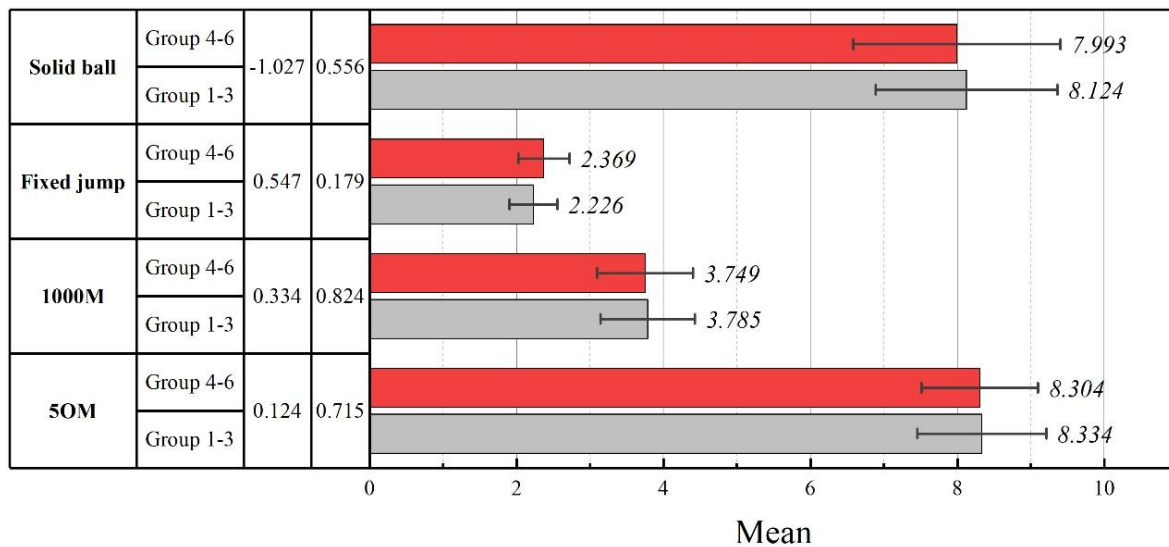


Figure 6: The results of the two groups of students were compared

The comparison of physical fitness test results of students in the control group after the ten-week multivariate teaching method integration teaching is shown in Figure 7. In the control group, the average time of students' 50-meter sprint before the experiment was 8.334s, and the average time after the experiment was 8.271s, and the average time of 50-meter sprint was shortened by 0.063s, and the P-value of the results of the paired T-test was 0.663, the difference was not significant, and the physical quality of the students under the traditional physical education teaching mode was not significantly improved.

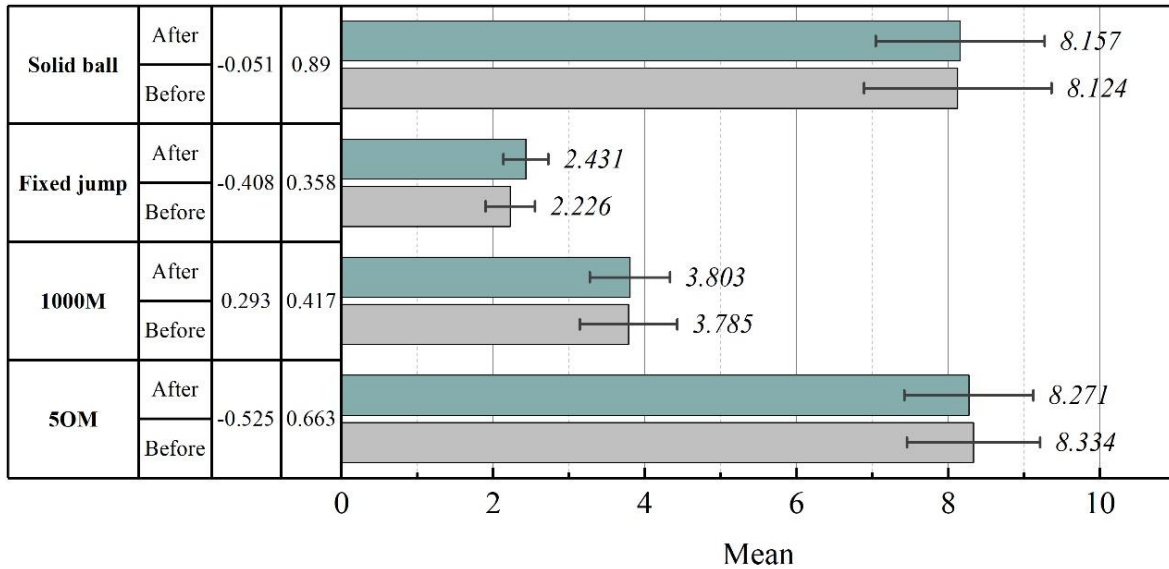


Figure 7: Test results of the physical quality of the control students after the experiment

The table shown in Figure 8 shows the results obtained from the pre-experiment and post-experiment physical quality tests for the experimental group. After adopting several methods of physical education instruction, the mean value of the 50-meter sprint improved by 0.222 seconds. In this case, the T-value was calculated to be 0.526 while the P-value of the paired t-test was calculated to be 0.043.

The 1000m performance increased by 0.274 points, standing long jump and solid ball increased by 0.295m and 0.386m respectively with the pre-test of pluralistic teaching, paired T-test results P-value is less than 0.05, before and after the difference in performance is significant, the observation teaching method, contextual teaching method and other teaching methods, including pluralistic fusion of teaching methods to carry out physical education can significantly improve the level of physical fitness of the students.

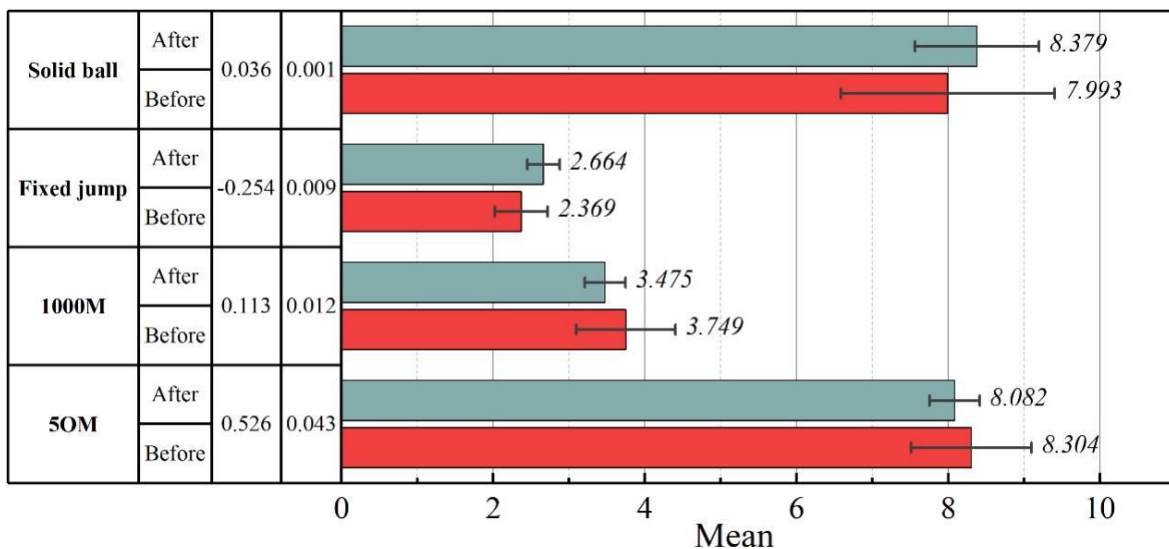


Figure 8: Before and after the experiment, the experimental results were compared

In summary, university physical education teaching under the integration of multiple teaching methods has shown significant improvement in students' physical fitness level after a ten-week teaching experiment. On the one hand, it may be due to the fact that the multiple

teaching methods can better carry out targeted teaching according to the students' needs, curriculum emphasis, and teachers' teaching preferences, and provide personalized development for the teaching of physical education courses. On the other hand, it may be due to the fact that the monocular human body localization method based on information fusion and the lightweight human skeleton key point detection network DHRNet designed in this paper can assess students' physical fitness in a lot of ways, which can provide technical support for the development of physical education teaching.

5 Conclusion

In this paper, observation-based teaching method, context-based teaching method and flipped classroom teaching method are integrated and applied to university physical education teaching, and a comprehensive physical fitness assessment model is constructed by combining the information fusion-based monocular human localization method and the lightweight human skeleton key-point detection network DHRNet, and the model is used to test the effect of physical education teaching with the integration of multi-methods of teaching and learning.

The DHRNet algorithm has the overall best prediction accuracy of key points in the three-scale network model, and the human skeletal key point detection results of multi-scale prediction and fusion are higher than those on the 4-fold downsampling, but the crotch detection results on the 8-fold downsampling are better than those on the 4-fold and 16-fold downsampling, and the algorithm's performance is continuously optimized through the refining network and the fusion network for the subsequent students' physical education experimental detection.

Students in the experimental group with multiple teaching methods improved their performance in 50m, 1000m, standing long jump, and solid ball in the comprehensive physical fitness assessment program, and the performance before and after the teaching experiment formed a significant difference, and the physical education teaching with multiple teaching methods can be used for the development of students' qualities and the teaching of the curriculum to carry out effective teaching and training, which is conducive to the improvement of the practice of teaching physical education in the university.

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