Multivariate Statistical Analysis Based on Random Matrix to Explore the Promotion Effect of Network Resource Sharing Mode on Physical Education

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Multivariate statistical analysis is a new statistical method emerging in recent years. Due to the continuous update and continuous development of Internet technology, statistical analysis of data from all walks of life is required. The method of multivariate statistics was soon applied to all walks of life, bringing great convenience to people's work and industry. The method of multivariate statistics is used to process and evaluate the data, guide the school's physical education work, and make suggestions for various functional units. This paper focuses on the multivariate statistical analysis of principal components and factors, uses factor analysis to comprehensively evaluate college students, and uses the variance method to make statistics on the four-year physical education performance of 141 undergraduates in grades 13 and four subjects. And based on this, the effect of different majors on their academic achievement is discussed. This paper believes that in college physical education, this method should be applied to daily physical education, and students should be rationally analyzed and scientifically evaluated. This model can make a comprehensive investigation of the education work so that their education work can be improved more effectively, and sports talents in colleges and universities can get better development.

1. Introduction

The study of multivariate statistics has been applied in many industrial fields. At present, universities in our country generally use the average level as the standard to measure the athletic ability of college students. Although this method is simple, it also has many drawbacks and limitations, and it is difficult to conduct a comprehensive evaluation of college students. Using the method of multivariate statistics, the academic achievement of college students has been scientifically and reasonably evaluated [1]. To this end, the research on the application of multivariate statistical analysis in the evaluation of college physical education is discussed.

Scholars at home and abroad have made some discussions on the application of multivariate statistics in universities [2]. Liu [3] used the factor analysis method to study the academic achievement of college students and found that factor analysis is better than the principal component method. Jinshi [4] discussed the application of principal component analysis and factor analysis in the evaluation of college students and modified its model. Xiaojuan [5] used weighted Mahalanobis distance discrimination method and cluster analysis method to optimize the evaluation model of university classrooms and carried out nonlinear transformation through BOX-COX to make it have a clearer classification. Yemeng [6] conducted a comprehensive analysis of the data through various analysis methods and combined the three main analysis methods such as discriminant analysis, factor analysis, and cluster analysis and discussed the correlation between the two. Peili [7] carried out statistical processing on the initial scores of 2229 ordinary high school mathematics subjects, classified them by variance analysis, and analyzed them from different perspectives and researched it; Wenmei [8] used the multivariate statistical methods to investigate various incentive factors affecting college
2. Factor Analysis and Cluster Analysis

2.1. Factor Analysis. Factor analysis is a data reduction technology based on dimensionality reduction thinking. It uses the correlation coefficient matrix of the measured variables to correlate them and extracts a number of independent and unrelated random variables that represent the correlation of each variable. To a certain extent, its expansion and development have become the main factor. To put it simply, the idea of reducing the dimension is adopted, and the original various variable indices are synthesized to make them irrelevant indicators.

Principal component analysis and factor analysis are two commonly used analysis methods in multifactor analysis. Although both can achieve the simplicity of data, there is a big difference between them [12]. The principal component method mainly studies the change of data and finds the linear combination of the initial variables through simple changes, that is, the principal component, so that the original variables can be processed simply without errors. Both the main factors are used to represent exponents, so there is no real meaning. The function of factor analysis is to explain the original variables and focus on the correlation between variables. Therefore, it is necessary to find the inherent correlation and possible common factors of the variables in order to better detect the structure of the data. The pattern contains an error derived from a set of drawn common factors and a random specific factor. Therefore, in the applicable field, the practical application of factor analysis is more extensive, and sometimes the main components can also be included.

2.2. Mathematical Model of Factor Analysis. Because the difference between the R-type factor analysis and the Q-type factor analysis mode is that in the Q-type factor model, \(X_1, X_2, \ldots, X_p\) are \(n\) samples, respectively, the corresponding Q-type mode in the R-type factor model is also different from the R-type factor analysis. Patterns are similar. Each variable in the R-type factor analysis can be expressed by the sum of the straight-line values of a specific factor and an unrelated common factor [13]:

\[
X_i = a_{i1}F_1 + a_{i2}F_2 + \cdots + a_{im}F_m + \varepsilon_i. \tag{1}
\]

Formulas \(F_1, F_2, \ldots, F_m\) are unrelated and unmeasurable common coefficients whose average is 0 and variance is 1 and can be represented by a random matrix:

\[
X = AF + \varepsilon, \tag{2}
\]

where \(A, F, \varepsilon\) are defined in (3):

\[
A = \begin{bmatrix} a_{11} & a_{12} & a_{1m} \\ a_{21} & a_{22} & a_{2m} \\ \vdots & \vdots & \vdots \\ a_{p1} & a_{p2} & a_{pm} \end{bmatrix} = (A_1, A_2, \ldots, A_m),
\]

\[
F_1 \quad F_2 \quad \cdots \quad \varepsilon_1
\]

\[
X = \ldots, F = \ldots, \varepsilon = \ldots.
\]

2.3. Cluster Analysis. Cluster analysis is a multidimensional statistical analysis that classifies samples or index variables. This method objectively analyzes the correlation between samples and index variables according to attribute characteristics without giving a classification criterion in advance. Therefore, the homogeneity of objects in the same class is higher than that of other types, and there is significant heterogeneity, that is, the difference between classes is large, and the difference between classes is very small [14]. According to the goal of cluster analysis, the content of cluster analysis can be divided into Q-type cluster analysis and R-type cluster analysis. The Q-type clustering method is to use the distance or correlation factor between the measured samples to gather the samples with a greater degree of correlation and distinguish the samples with a higher degree, and Variable R clustering is to cluster the correlation between items, and then determine the category according to the strength of the correlation, so that the variables with high similarity are concentrated, and the variables with large differences are separated. The R-type clustering results can also be obtained by factor analysis. Among different variables with high correlation, some representative ones are selected to reduce the overall variables and thus reduce the dimension. The difference between the two is very small, but because of the factor analysis method of dimensionality reduction thinking, its theoretical model is more systematic and more credible. Therefore, factor analysis is often used in variable clustering, while R-type clustering analysis is rare. Figure 1 shows the overall classification method for cluster analysis.

3. The Application of Multivariate Statistical Analysis in the Evaluation of College Students’ Physical Education

3.1. Construction of Evaluation Index System. To establish the evaluation index system, the most important thing is to
reflect the integrity of the evaluation object [15]. As the research goal of the thesis, it is to evaluate the physical education of college students, so the evaluation indicators of this system should be able to fully reflect the various qualities of college students.

In general, the evaluation index system of physical education evaluation in colleges and universities should include a comprehensive evaluation of both theory and practice. Therefore, the author studies 12 typical problems from five aspects: ideological and moral education, physical and mental health education, theoretical knowledge, accumulation, and practical innovation. This subject takes the undergraduates of our school as samples, comprehensively summarizes the specific answers to 12 specific questions, obtains the original data, and analyzes it in combination with the scores of each indicator.

3.2. Normalize the Raw Data and Calculate the Correlation Coefficient Matrix. Because the measurement unit of each index in the original data is different, if it is analyzed directly, it will be evaluated and must be normalized [16]. Through the normalized data of SPSS, the correlation degree between variables is obtained through the data, and the correlation degree of each factor is discretized (see Figure 2).

It can be seen from the scatter diagram that the correlation degree between most variables is greater than 0.3, which shows that there is a good correlation and collinear relationship between them, and they meet the requirements of factor analysis. To give more credibility to the original variable, we combined SPSS with KMO and Bartlett’s test to compare it with Bartlett’s method, and the results were as follows.

As can be seen from Table 1, the statistical value of Bartlett’s method is 502.458 and the probability $P$ of $P$ is close to 0. Therefore, we can reject the original assumption: the correlation factor and the element matrix are not significantly different; that is, the correlation of these variables is linear. Approaching 1 from 0.870 of KMO further proves that the original variable is suitable for factors.

3.2.1. Extract Common Factors. In order to reduce the loss in the original data, the collinearity in the original data is removed, so that the analysis effect is closer to the actual [17]. The basic criteria for selection are the cumulative variance contribution of each factor is not less than 80%, and the SPSS method is used to obtain the eigenvalues, variance contribution, and other indicators, as shown in Table 2.

From Table 2, in the analysis of the original factor solution, the former factor has a characteristic root value of 5.94, which can be used to explain 49.486% of the variance of the original 12 variables, and after the factor is rotated, its variance contribution is only 17.92%. In order to minimize
the influence of the data, we selected five factors, and after excluding all factors, we obtained more information and obtained better results.

3.2.2. Calculate Factor Scores. The factor scoring coefficient matrix describes the factor coefficients, and the factors are named $F_1$, $F_2$, $F_3$, $F_4$, and $F_5$ in the system. The coefficient matrix of factor score is shown in Table 3.

Using the expression method of the five main components, each index is introduced to the five main factors. By weighting the different contribution coefficients of the five factors, they are analyzed separately, and the corresponding total score formula is obtained:

$$F = 0.1792 \times F_1 + 0.16618 \times F_2 + 0.1649 \times F_3 + 0.1501 \times F_4 + 0.1497 \times F_5. \quad (4)$$

Through analysis, we can find out which people have better overall quality and can be ranked by different factors to judge their ideological morality, mental health, and accumulation of theoretical knowledge, so as to better improve their overall quality. According to this situation, we found several students with large offsets and drew a bar chart (as shown in Figure 3). It can be seen from the bar chart that although the three students 20, 55, and 73 have poor performance in physical education, their performance in physical education is still good, which means that they have good performance in life, mind, body, and so on. There is a great advantage, and in the future society, they may be the best candidates. The situation of other students is just the opposite. They have advantages in sports, but they are insufficient in other fields and need to improve their other qualities.

3.3. Application of Cluster Analysis. Using the above factor analysis method, a clustering study was carried out on 80 interviewed college students. The sampling is divided into five categories by the method of factor analysis, as shown in Table 4. The number of cases in each cluster is shown in Table 5.

Using SPSS for the above cluster and factor analysis, it is found that each category is relatively scattered, the fourth category is the majority, and the corresponding third category is relatively small. As can be seen from the subdivision Table 5, among the 19 people in category 1, the scores of each

| Table 1: Bartlett sphericity test and KMO test. |
|-----------------------------------------------|
| Kaiser-Meyer-Olkin measure of sampling adequacy | 0.870 |
| Bartletts test of sphericity                   |      |
| Approx. Chi-Square                             | 502.458 |
| df                                            | 66   |
| Sig.                                          | 0.000 |

| Table 2: Factors explaining the total variance of the original variables. |
|-------------------------------------------------------------|
| Table of eigenvalue and cumulative variance contribution rate |
| Number | Initial solution | Initial factor solution | Final factor solution | difference |
|--------|------------------|-------------------------|-----------------------|------------|
| 1      | 5.94             | 49.49                   | 49.49                 | 5.95       | 49.48   | 49.49   | 2.14 | 17.91 | 17.91 |
| 2      | 1.20             | 9.79                    | 59.46                 | 1.22       | 9.98    | 59.44   | 1.98 | 16.62 | 34.53 |
| 3      | 1.05             | 8.76                    | 68.22                 | 1.03       | 8.76    | 68.23   | 1.98 | 16.48 | 51.02 |
| 4      | 0.9              | 7.49                    | 75.70                 | 0.91       | 7.46    | 75.71   | 1.82 | 15.10 | 66.12 |
| 5      | 0.65             | 5.4                     | 81.10                 | 0.6        | 5.3     | 81.01   | 1.81 | 14.98 | 81.0  |
| 6      | 0.49             | 4.07                    | 85.17                 |            |         |         |      |       |      |
| 7      | 0.41             | 3.42                    | 88.59                 |            |         |         |      |       |      |
| 8      | 0.36             | 2.99                    | 91.59                 |            |         |         |      |       |      |
| 9      | 0.32             | 2.64                    | 94.21                 |            |         |         |      |       |      |
| 10     | 0.30             | 2.46                    | 96.68                 |            |         |         |      |       |      |
| 11     | 0.22             | 1.87                    | 98.55                 |            |         |         |      |       |      |
| 12     | 0.17             | 1.45                    | 100.00                |            |         |         |      |       |      |

| Table 3: Factor score coefficient matrix. |
|-------------------------------------------|
| Component | 1   | 2   | 3   | 4   | 5   |
| Zscore (X1) | −0.113 | 0.112 | −0.193 | 0.489 | 0.062 |
| Zscore (X2) | −0.028 | −0.195 | −0.015 | 0.653 | −0.109 |
| Zscore (X3) | 0.372 | 0.085 | −0.407 | −0.245 | 0.407 |
| Zscore (X4) | 0.688 | −0.315 | −0.105 | 0.016 | −0.106 |
| Zscore (X5) | 0.188 | 0.227 | 0.056 | 0.078 | −0.260 |
| Zscore (X6) | 0.090 | 0.200 | 0.089 | −0.042 | −0.055 |
| Zscore (X7) | −0.260 | 0.715 | −0.148 | −0.078 | −0.006 |
| Zscore (X8) | 0.113 | 0.131 | 0.408 | −0.036 | −0.355 |
| Zscore (X9) | −0.049 | 0.059 | 0.348 | 0.026 | −0.096 |
| Zscore (X10) | −0.194 | −0.208 | 0.702 | −0.112 | −0.013 |
| Zscore (X11) | −0.263 | −0.077 | 0.019 | 0.013 | 0.614 |
| Zscore (X12) | 0.062 | −0.136 | −0.163 | −0.022 | 0.563 |
Figure 3: Comparison of comprehensive rankings and sports rankings.

Table 4: Cluster analysis results.

| Number | F_1  | F_2  | F_3  | F_4  | F_5  | Type |
|--------|------|------|------|------|------|------|
| 1      | 0.45 | 0.86 | 1.23 | 1.45 | 0.85 | 5    |
| 15     | 0.06 | 0.31 | 0.23 | 1.2  | 0.06 | 5    |
| 16     | 0.42 | 0.35 | 1.6  | 1.09 | 5    |
| 20     | 2.14 | 0.02 | 2.02 | 1.73 | 1.02 | 5    |
| 29     | 0.89 | 0.78 | 1.39 | 0.59 | 1.12 | 5    |
| 41     | 0.68 | 0.79 | 1.05 | 1.27 | 1.21 | 5    |
| 42     | 0.38 | 0.88 | 1.13 | 1.04 | 1.43 | 5    |
| 43     | 1.84 | 0.86 | 1.26 | 0.09 | 0.56 | 5    |
| 47     | 0.79 | 0.43 | 1.56 | 1.51 | 0.55 | 5    |
| 50     | 0.99 | 0.71 | 0.68 | 0.73 | 0.34 | 5    |
| 56     | 0.74 | 0.41 | 1.54 | 0.15 | 1.29 | 5    |
| 63     | 1.88 | 1.24 | 1.07 | 0.01 | 0.97 | 5    |
| 65     | 0.78 | 0.08 | 1.94 | 0.32 | 0.21 | 5    |
| 66     | 1.95 | 0.63 | 0.33 | 0.18 | 0.33 | 4    |
| 7      | 0.4  | 1.39 | 0.87 | 1.54 | 0.03 | 4    |
| 13     | 0.13 | 0.14 | 0.11 | 0.19 | 0.39 | 4    |
| 14     | 0.46 | 0.04 | 0.42 | 0.16 | 1.11 | 4    |
| 14     | 1.84 | 1.17 | 1.77 | 0.43 | 0.45 | 4    |
| 25     | 1.03 | 1.27 | 1.83 | 1.43 | 4    |
| 28     | 1.49 | 0.85 | 0.17 | 0.38 | 4    |
| 30     | 0.14 | 0.12 | 0.31 | 1.98 | 1.14 | 4    |
| 35     | 0.3  | 0.09 | 0.96 | 0.66 | 0.92 | 4    |
| 53     | 0.35 | 0.94 | 1.4  | 0.55 | 0.03 | 4    |
| 58     | 1.77 | 0.92 | 1.76 | 2.27 | 0.04 | 4    |
| 60     | 1.95 | 0.02 | 1.57 | 1.55 | 0.23 | 4    |
| 61     | 1.66 | 1.64 | 1.73 | 0.24 | 0.61 | 4    |
| 64     | 1.17 | 0.54 | 0.31 | 1.14 | 1.04 | 4    |
| 66     | 1.67 | 0.31 | 0.25 | 0.28 | 0.32 | 4    |
| 67     | 1.37 | 1.18 | 1.42 | 0.06 | 0.45 | 4    |
| 73     | 0.12 | 1.11 | 0.27 | 1.6  | 0.91 | 4    |
| 74     | 0.18 | 1.14 | 0.72 | 0.19 | 1.45 | 4    |
| 7      | 0.69 | 1.63 | 0.61 | 0.53 | 1.5  | 4    |
| 80     | 2.1  | 0.37 | 1.23 | 0.4  | 0.46 | 4    |
| 9      | 2.24 | 2.1  | 1.42 | 0.26 | 1.3  | 3    |
| 10     | 1.11 | 1.68 | 0.95 | 1.63 | 0.85 | 3    |
| 11     | 0.08 | 0.42 | 1.78 | 0.34 | 1.38 | 3    |
| 12     | 0.87 | 0.64 | 0.22 | 1.63 | 1.55 | 3    |
| 13     | 2.28 | 0.73 | 0.73 | 0.71 | 1.21 | 3    |
| 14     | 0.19 | 1.31 | 0.63 | 0.53 | 0.83 | 3    |

Type:
1 Comprehensive ranking
2 Sports rankings
person’s 5 main factors can be found that most of the values of \( F_2 \) are larger than others, which indicates that the theoretical knowledge of students in category 1 is more, accounting for 23.75% of the proportion; therefore, among all students, the proportion of sports knowledge is not too high.

The second group has a total of 17 members, and their \( F_5 \) factor scores are higher than other factors, while the fifth item contains descriptions of sports expertise and life satisfaction, indicating their daily management level, in the overall. The percentage of scores is moderate.

### 3.4. The Test of Discriminant Analysis

There are two functions of the discriminant method: one is to judge and classify new samples; the other is to effectively verify the already classified samples. After using factor analysis and cluster analysis, to test the validity of the classification, the auxiliary function of discriminant analysis must be used, and a discriminant function must be established. When new data appear, the type of the sample can be quickly judged. The SPSS was divided by the Bayesian discriminant method, and a discriminant function based on the SPSS was obtained (Table 6).

It can be seen from Table 6 that there is little difference between the classification after classification and the classification after identification, and the probability of each classification is high. After classification and comparison, only 2 samples were significantly different in classification, and the similarity with clustering was as high as 97.5%. Table 7 lists the final synthesis results.

It can be seen from the table that 19 people have a high level of theoretical knowledge, and the regression analysis was carried out using the regression method, 17 people were in line with the reality, and 2 people were wrongly assigned to 3 (poor students). Therefore, a set of data is 89.5% correct. There is no error in the classification of the second, third, fourth, and fifth categories, and the effect of the classification is basically consistent with the classification method of the classification. Finally, the samples were segmented by the \( K \)-means clustering method based on Bayesian discrimination and clustering. From the analysis results, using the above factor analysis, cluster analysis, discriminant analysis, and other methods to evaluate the comprehensive quality of college students, can better evaluate the college students’ sports indicators.

In this relatively liberal university, many college students prefer to do according to their hobbies and only do what they like, resulting in their limited knowledge acquisition and inability to fully understand their own development. Over time, it will lead to an imbalance in the development of various qualities and skills. Therefore, colleges and universities and teachers should pay attention to the all-around training and improvement of colleges and universities. On the basis of attaching importance to students’ cultural courses, strengthening students’ physical quality, expanding students’ cultural horizons, and promoting students’ physical and mental development, students should be evaluated from multiple perspectives, and various information of students should be collected earnestly and comprehensively so that everyone can find their own strengths and weaknesses and avoid extreme situations. As the ultimate beneficiaries of the comprehensive quality assessment of colleges and universities, colleges and universities should understand their own strengths and weaknesses and actively cooperate with social colleges to carry out
comprehensive quality assessment work to improve themselves comprehensively.

3.5. Other Applications of Multivariate Statistical Analysis in Higher Education Evaluation. Higher education is a comprehensive and diversified system, and its main functions include cultivating high-quality talents, scientific research, serving the society, and cultural innovation. The evaluation of colleges and universities is an effective means to effectively supervise whether colleges and universities can develop in a normal and orderly manner. The article investigates and evaluates the overall quality of college graduates and reveals some problems existing in colleges and universities, including the overall quality development of college teachers and teachers’ educational concepts. It can be seen that it is very beneficial to use various methods of multivariate statistics to evaluate China’s higher education system. This paper only analyzes the macro problems of colleges and universities in detail, so that it can be used in other fields.

4. Conclusion

It can be seen from the factor analysis that in the factor analysis of college students, the cumulative variance contribution ratio of the selected factors should be more than 75%, and the variance contribution value can better explain the significance of these factors. Using this method to evaluate students, the results are objective and true, which can fully reflect the students’ comprehensive quality and sports quality and can also intuitively reflect the students’ various qualities, so as to have a positive effect on the student’s study and work. Through the variance analysis of the variation of the academic level of sports college students, it is found that different occupations have no effect on their academic level. In other words, these people have similar strengths and will not be restricted by different professional conditions. At the same time, it also shows that there is no distinction between good and bad majors but only the diligence of the students. This can inspire students to study hard and get excellent grades no matter what their occupation is.

In college physical education, the study of multivariate statistical analysis will be paid more and more attention, and the study of multivariate statistical analysis will become a new direction of college physical education research. On this basis, the principal component method and factor method are used to comprehensively evaluate colleges and universities, and the application of this method in colleges and universities is discussed, and the teaching quality evaluation and employment guidance in colleges and universities are discussed. The use of multivariate statistics in other areas of the university and beyond needs to be explored in greater depth.

Data Availability

The dataset used in this paper is available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding this work.

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