Research Article

Analytic Hierarchy Process of the Evaluation System of Physical Education Teaching Quality in Colleges and Universities

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Abstract

In view of how to accurately evaluate the quality of physical education (PE) in colleges and universities, this study puts forward a method of fuzzy analytic hierarchy process (FAHP), and uses this method to make in-depth research on the evaluation system of P.E. teaching quality. Firstly, this study introduces the current evaluation system of PE teaching quality, and analyzes its shortcomings. Then, this study deals with the analytic hierarchy process (AHP), and puts forward a new FAHP according to the characteristics of PE teaching and by referring to the relevant knowledge of fuzzy mathematics. Finally, by using the new FAHP, the evaluation system of PE teaching quality in colleges and universities is studied. The empirical analysis shows that the method proposed in this study can accurately evaluate PE teaching quality in colleges and universities. The research results provide theoretical support for the establishment of scientific evaluation system of PE teaching quality in colleges and universities, and also provide useful reference for the research of teaching quality evaluation system in other fields of higher education.

Keywords

PE • Teaching Quality Evaluation • AHP • Higher Education

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In order to more accurately evaluate PE teaching quality in colleges and universities, this study combines the existing AHP theory with fuzzy mathematics, and proposes a new AHP, and uses this method to explore the evaluation system of PE teaching quality in colleges and universities.

As there is a big gap between the current PE teaching and the established goal in colleges and universities, it has always been a concern to improve the PE teaching level in the field of higher education. The premise of improving PE teaching level is to accurately evaluate the current PE teaching quality, so the research of evaluation system of PE teaching quality is always the focus of PE teaching research, and is also the acknowledged difficulty in PE teaching research field. In the research work that has been carried out, some researchers will focus on the macroscopic discussion of the evaluation frame of PE teaching quality, clarify the feasibility and research path of teaching evaluation (Larry & Hensley, 1997). Some researchers have studied the choice of evaluation index of teaching quality and the design of evaluation scale (Melograno, Graber & Woods, 2007). Some researchers emphasize the specific implementation process of the evaluation (Shahril, Salimin & Elumalai, 2015). Some researchers take the teaching goal as the guidance and complete the final evaluation to the PE teaching quality through the research of teaching motive (Gimeno & García-Mas, 2005). Some researchers have designed and developed the evaluation management system of PE teaching quality from the point of view of teaching convenience (Mishra, Jain & Hooda, 2016). The above is in the research progress of evaluation of PE teaching quality. For the research aspect of AHP, the forefathers have obtained the relatively abundant research result. Some researchers have fully expounded the theoretical basis of AHP (Saaty & Vargas, 2013). Some researchers systematically introduce various models, concepts and applications of AHP (Saaty & Vargas, 2012). Some researchers have focused on the comparative study of determining the weight coefficients of AHP (Ho, 2008). Some researchers analyze the main development context, deficiency and possible improvement direction of the existing AHP (Ishizaka & Labib, 2011). Some researchers have studied the initial combination of fuzzy logic and AHP [10] (Mikhailov & Tsvetinov, 2005). Although the predecessors have done a lot of beneficial research work, the application of AHP to the evaluation of PE teaching quality according to the characteristics of PE is still lacking.

In order to improve the accuracy of evaluation of PE teaching quality in colleges and universities, this study proposes a research method of teaching quality evaluation system based on FAHP. The research results provide important theoretical support for the establishment of scientific and accurate evaluation system of PE teaching quality in colleges and universities, and also provide reference for other professional teaching quality evaluation research.

The first part is introduction and the second part introduce the development status of the evaluation system of P. E. teaching quality and the deficiency of the present research. The third part introduces the general AHP, and puts forward a new FAHP. The fourth part studies the evaluation system of PE teaching quality based on FAHP, and the fifth part is the conclusion.

Research Status of the Evaluation System of PE Teaching Quality

The current research work on the evaluation system of PE teaching quality mainly carries out theoretical research on the basic concepts, principles and methods from the perspective of qualitative analysis. In general, on the basis of questionnaire survey, the evaluation of PE teachers, college students, PE experts and PE teaching supervisors are simply integrated. The score of each teaching index is integrated as the final score of PE teaching quality. This kind of evaluation system mainly depends on the qualitative analysis, the subjective interference of the parties involved in the survey is large, the scientific rigor of the teaching quality measurement process is not enough, and the final evaluation accuracy is not high, which leads to poor guidance to the subsequent PE teaching. In recent years, a small number of researchers have introduced quantitative analysis methods such as AHP into the research of the evaluation system of PE teaching quality, but have not improved the adaptability of the AHP model according to the characteristics of PE teaching. Therefore, based on the quantitative analysis method to study the evaluation of PE teaching quality, there is still room for further discussion.

AHP

General AHP

In the 1970s, AHP was first proposed by American researchers to introduce quantitative analysis into the field of sociology and make the decision-making process more scientific and accurate through mathematical reasoning. The main idea of AHP is to enumerate the factors that influence the final decision-making after abstracting the problem. Then all the factors are treated hierarchically according to different stages and mutual subordination. Finally, all the factors are compared and the importance ranking is given. The main steps of AHP are as follows:

(1) According to the characteristics of the studied problem and the traditional performance evaluation index, a multi-level hierarchical model is established which generally includes a target layer A, a middle layer B and an index layer C.

(2) Based on the suggestions of educational experts, the suggestions of the parties involved in teaching and the teaching practice, the judgment matrix at all levels is constructed. The importance of each factor in the matrix is generally carried out by 1-9 scale method.

(3) By means of hierarchical single ranking, hierarchical total ranking and consistency checking, the importance analysis of factors at all levels is completed, and then the weight distribution of each index to achieve the goal is obtained.

New FAHP

The comparison of the importance of the two indexes affecting the evaluation of PE teaching quality results in the fact that the 1-9 scale method and the subsequent importance ranking calculation are not completely

applicable due to the ambiguity of the experts' suggestions or the fuzzy attributes of the indexes themselves. In view of the characteristics of PE teaching and further reducing man-made interference, a new FAHP is proposed in this section. The main steps of this method are as follows:

(1) A multi-level hierarchical structure model is established, which generally includes a target layer A, a middle layer B, and an index layer C.

(2) A judgment matrix J constructed on the basis of the 1-9 scale method;

(3) A questionnaire survey is conducted on the judgment matrix J to understand the recognition degree of each teaching party of the matrix J. The fuzzy matrix F is formed by the recognition degree, and then the corresponding elements of the judgment matrix J and the fuzzy matrix F are multiplied to obtain the final judgment matrix J^*;

(In section 4.4, the construction of the judgment matrix J, the fuzzy matrix F, and the final judgment matrix J^* is described in detail in combination with an example of PE teaching)

(4) On the basis of the final judgment matrix J^*, the weight distribution of each index to the goal is obtained.

Study on Evaluation System of PE Teaching Quality Based on FAHP

Research object

In order to comprehensively and objectively analyze PE teaching quality in different colleges and universities, and to facilitate the follow-up popularization of the research results, this study selects students majoring in PE in 5 normal colleges and universities and students of non-PE major in 5 comprehensive colleges and universities as the research object. The composition distribution of the research object is shown in Table 1.

Table 1
Research Object

University type	University number	Major	Student number
Normal university	University 1	Physical education	50
	University 2	Sports management	50
	University 3	Sports training	50
	University 4	Traditional sports	50
	University 5	Social sports	50
Comprehensive university	University 6	Management Science and Engineering	50
	University 7	Electrical engineering	50
	University 8	Industrial economics	50
	University 9	Surgery	50
	University 10	Biological Engineering	50

Construction of index system of quality evaluation system

The construction of evaluation index system of PE teaching quality in colleges and universities is complicated. Because of the complexity of educational behavior itself and the coupling relationship between the involved factors, many evaluation index systems have been put forward. In order to abstract the problem,

this study divides the evaluation index system of PE teaching quality into three layers under the premise of not losing accuracy. The target layer A is the final evaluation of teaching quality. The middle layer B is divided into teacher teaching evaluation B1 and student learning evaluation B2. The index layer C includes 10 indexes C1-C10, wherein C1-C5 are refinements of the teacher teaching evaluation B1, and C6-C10 are refinements of the student learning evaluation B2. The construction of the index system of quality evaluation system is shown in Table 2.

Table 2
Evaluation System of PE Teaching Quality in Universities

Target layer A	Middle layer B	Index layer C
Evaluation of PE teaching quality	Evaluation of teacher teaching (B1)	Teaching preparation (C1)
		Teaching organization (C2)
		Teaching content (C3)
		Teaching methods (C4)
		Teaching skills (C5)
	Evaluation of student learning (B2)	Improvement of ability (C6)
		Learning interest (C7)
		Personality development (C8)
		Collaboration (C9)
		Sound quality (C10)

AHP of index of quality evaluation system

The AHP of the evaluation index system of PE teaching quality in colleges and universities is still based on the 1-9 scale method. The scale description is shown in Table 3.

Table 3
Scale Description of Importance Comparison in Analytic Hierarchy Process (take the comparison of Ci and Cj as an example)

Scale	Description
1	Ci is of equal importance to Cj.
2	Compared with Cj, Ci is more important than scale 1.
3	Compared with Cj, Ci is more important than scale 2.
4	Compared with Cj, Ci is more important than scale 3.
5	Compared with Cj, Ci is more important than scale 4.
6	Compared with Cj, Ci is more important than scale 5.
7	Compared with Cj, Ci is more important than scale 6.
8	Compared with Cj, Ci is more important than scale 7.
9	Compared with Cj, Ci is more important than scale 8 and reaches the maximum.
1,1/2,1/3,1/4,1/5,1/6,1/7,1/8,1/9	Compared with Cj, the importance of Ci is exactly the opposite of the above lines

On the basis of the scales listed in Table 3, each judgment matrix between the target layer A, the middle layer B, and the index layer C is constructed. The judgment matrix J1 of the target layer A and the middle layer B, the judgment matrix J2 of the middle layer B1 and the index layer C, and the judgment matrix J3 of the middle layer B2 and the index layer C are shown in Tables 4, 5 and 6, respectively.

Table 4
Judgment Matrix J1 of Target Layer A and Middle Layer B

A	B1	B2
B1	1	1
B2	1	1

Table 5
Judgment Matrix J2 of Middle Layer B1 and Index Layer C

B1	C1	C2	C3	C4	C5
C1	1	2	6	1/5	3
C2	1/2	1	4	1/7	2
C3	1/6	1/4	1	1/9	1
C4	5	7	9	1	8
C5	1/3	1/2	1	1/8	1

Table 6
Judgment Matrix J3 of Middle Layer B2 and Index Layer C

B2	C6	C7	C8	C9	C10
C6	1	5	2	1/2	6
C7	1/5	1	1/3	1/7	2
C8	1/2	3	1	1/4	3
C9	2	7	4	1	9
C10	1/6	1/2	1/3	1/9	1

Then, the recognition degree is conducted on judgment matrices J1-J3 by questionnaire, and the corresponding fuzzy matrices are obtained. The fuzzy matrices F1, F2, and F3 are shown in Tables 7, 8, and 9, respectively.

Table 7
Fuzzy Matrix F1

A	B1	B2
B1	1	0.92
B2	0.92	1

Table 8
Fuzzy Matrix F2

B1	C1	C2	C3	C4	C5
C1	1	0.86	0.61	0.72	0.58
C2	0.86	1	0.93	0.63	0.75
C3	0.61	0.93	1	0.92	0.77
C4	0.72	0.63	0.92	1	0.49
C5	0.58	0.75	0.77	0.49	1

Table 9
Fuzzy Matrix F3

B2	C6	C7	C8	C9	C10
C6	1	0.49	0.56	0.82	0.67
C7	0.49	1	0.75	0.90	0.59
C8	0.56	0.75	1	0.87	0.84
C9	0.82	0.90	0.87	1	0.67
C10	0.67	0.59	0.84	0.67	1

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Table 10
Final Judgment Matrix J1**

A	B1	B2
B1	1	0.92
B2	0.92	1

Table 11
Final Judgment Matrix J2**

B1	C1	C2	C3	C4	C5
C1	1	1.72	3.66	0.144	1.74
C2	1.72	1	3.72	0.09	1.5
C3	3.66	3.72	1	0.102	0.77
C4	0.144	0.09	0.102	1	3.92
C5	1.74	1.5	0.77	3.92	1

Table 12
Final Judgment Matrix J3**

B2	C6	C7	C8	C9	C10
C6	1	2.45	1.12	0.41	4.02
C7	2.45	1	0.25	0.129	1.18
C8	1.12	0.25	1	0.218	2.52
C9	0.41	0.129	0.218	1	6.03
C10	4.02	1.18	2.52	6.03	1

Finally, the judgment matrices J1-J3 are multiplied by the corresponding fuzzy matrices F1-F3 as elements to obtain a final judgment matrix. The final judgment matrices $J1^*$, $J2^*$ and $J3^*$ are shown in Tables 10, 11 and 12, respectively.

Calculation of index weight of quality evaluation system

On the basis of the final judgment matrices $J1^*$, $J2^*$ and $J3^*$, the weight of each factor of the index layer in the evaluation system of PE teaching quality in colleges and universities is obtained by using the hierarchical single ranking, the hierarchical total ranking and the consistency check. Specific methods and formulas for the hierarchical single ranking, the hierarchical total ranking and the consistency check can be found in document [6] (Saaty, 2013) or document [8] (Ho, 2008). The weight of each index in the evaluation system of PE teaching quality in colleges and universities is shown in Table 13.

Table 13
The Weight of Each Index in the Evaluation System of Physical Education Teaching Quality in Universities

Index name	Weight coefficient
Teaching preparation (C1)	0.06
Teaching organization (C2)	0.05
Teaching content (C3)	0.07
Teaching methods (C4)	0.05
Teaching skills (C5)	0.12
Improvement of ability (C6)	0.16
Learning interest (C7)	0.12
Personality development (C8)	0.13
Collaboration (C9)	0.11
Sound quality (C10)	0.13

As can be seen from Table 13, the weight coefficients of the indexes C6-C10 related to the student learning evaluation B2 are higher than those of the indexes C1-C5 related to the teacher teaching evaluation B1 as a whole. It can be concluded that students are the main body of the teaching process, and the learning effect of students is the main aspect of evaluating the PE teaching quality in colleges and universities. At the same time, as can be seen from Table 13, the three indexes with the largest weight coefficient are ability improvement (weight coefficient 0.16), personality display (weight coefficient 0.13) and healthy personality (weight coefficient 0.13). Therefore, it can be concluded that the improvement of students' ability is the most important factor to evaluate the PE teaching quality in colleges and universities. If the students do not acquire the corresponding ability required by the teaching program, the teaching quality will not be discussed. The students' personality display is another main factor to evaluate the teaching quality, which is consistent with the teaching idea of respecting students as the main body of education and giving full play to students' subjective initiative. Students' healthy personality is also the main factor to evaluate the teaching quality, which is consistent with the final teaching goal of PE teaching and the ultimate goal of higher education.

Conclusion

This study deals with the AHP of the evaluation system of PE teaching quality in colleges and universities. Firstly, it introduces the status quo of the evaluation system of PE teaching quality, and analyzes the deficiencies of various research routes. Then, based on the general AHP and the characteristics of PE teaching, a new FAHP is proposed. In the end, based on the new method, students majoring in PE in normal colleges and universities and non-PE students in comprehensive colleges and universities are taken as the research object to deeply analyze and study the evaluation system of PE teaching quality in colleges and universities through the construction of index system, index hierarchy analysis and index weight calculation. The empirical analysis shows that the method proposed in this study can accurately evaluate the PE teaching quality in colleges and universities. The research results provide a theoretical reference for the scientific establishment of the evaluation system of PE teaching quality in colleges and universities, as well as a useful exploration for related research in other fields.

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