Comprehensive Evaluation Model of Physical Education based on Grey Clustering Analysis

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Abstract

This paper first introduces the implementation scheme design of the comprehensive evaluation of physical education, and then uses examples to verify the effect of the model constructed in this study, with the application of the traditional evaluation method, namely total score method into the practice to be analysed by comparing with the model of this study. Through practical test, it is obtained that the evaluation index system in this study is basically scientific, reasonable and feasible, and the evaluation result is basically consistent with the actual situation, thus it verifies the conclusion that the model in the case of small sample can ensure the validity of the evaluation results.

Keywords: The comprehensive evaluation of physical, Small sample, Physical education evaluation.

1. INTRODUCTION

Physical education evaluation refers to the process in which the teaching participants take students’ development as the goal and use the scientific method to conduct evaluation and value judgment for the physical education students’ learning quality and level. Learning outcome assessment is an important part of student’s learning, and the basis for teaching organization in the teaching process. By evaluating to know the situation that each student masters knowledge, teachers carry on the different relearning for every student, so as to make students’ learning fully improved. Learning outcome assessment has the remarkable effect on improving learning. Its meaning and effect is mainly reflected in its feedback regulation and monitoring, learning support, and optimizing education, etc. With evaluation, teachers constantly discover problems, improve teaching and learning methods, etc., to promote the all-round development of students. Scientifically evaluating students’ learning outcome is an important condition of the effective teaching, and also the standard to prove whether teaching is really effective. Concept of quality education should pay attention to the students’ learning, the evaluation of the learning process, and the change of emotion and attitude in the practice of the learning. Comprehensive evaluation for students is the effective way for students to test their overall learning effect in the learning process (Cui, 2014). Through the learning evaluation, students can understand the overall situation of learning in the learning process in a more specific and detailed manner, so as to facilitate students to adjust learning method (Papastergiou, 2009).

Since the connotation of learning outcome in the quality education is different from the connotation of traditional learning, the traditional learning outcome assessment takes the student’s test scores as assessment content, and fully uses quantitative evaluation to get the assessment results. And in addition to evaluating the student’s test scores, learning outcome assessment under the quality education should also take student’s emotion, learning attitude, moral emotion, and comprehensive quality in the process of learning as evaluation content. This study will add these qualitative evaluation contents into the assessment to comprehensively evaluate the student’s learning outcome(Zhang, 2014). Since these qualitative evaluation contents are characterized by uncertainty and fuzziness, combined with the grey characteristics of teaching system, this study will use the grey clustering technology with a unique advantage in the grey system to process the information, and then make comprehensive evaluation of student’s learning outcome(Li,2014).

To apply grey system in the comprehensive evaluation of physical education teaching can make full use of the advantage of the gray system in dealing with uncertain and fuzzy information to effectively solve grey information in the comprehensive evaluation of learning effect, avoid using precise mathematics to process fuzzy information with result deviation(Ying, 2016). At the same time, the application of grey system theory in the learning effect evaluation solves the prominent problem of a small amount of evaluation data in the learning process, and avoids the evaluation result deviation caused by the small data quantity. Meanwhile, grey clustering technology is used to construct model for the comprehensive evaluation of learning effect; because there are a fewer samples and data to
be processed, it can be faster and simpler than other methods to get the evaluation results that are close to the accuracy. Therefore, this study has not only theoretical research significance, but also practical application significance.

2. DESIGN STRATEGY AND METHOD OF SINGLE-CLASS EVALUATION INDEX OF PHYSICAL EDUCATION

Physical education comprehensive evaluation produces the evaluation results by multiple indexes with comprehensive consideration. To conduct the comprehensive evaluation, it must firstly carry on the evaluation of single-class index, because the specific evaluation index can be determined in differentiating index categories. Single-class index evaluation is the grade of evaluation objects on this kind of evaluation index, but the quality of an object on a kind of evaluation index does not represent the overall quality of the evaluation object, therefore, when it needs to understand the overall solution of evaluation object, it needs to establish a comprehensive evaluation model, combining with all kinds of evaluation index to conduct the integrated evaluation of the evaluation objects. When the evaluation result is basically consistent with the teacher’s and the students’ overall evaluation of the student, which shows the evaluation result is reasonable; otherwise, it should continue to investigate the sample values of the student for reappraisal. Learning outcome assessment process is shown in figure 1.

![Figure 1. Single-class evaluation index of physical education flow figure](image)

3. LEARNING EFFECT COMPREHENSIVE EVALUATION BASED ON GREY CLUSTERING LECE-GC

3.1 Model building

White function is the function expression for the possibility of each element’s value in grey class, and is used to
describe the deviator of a grey number with the different value within its scope. White function is, in general, is designed by the researchers according to the known information, and without fixed design formula, but deteriorating the function’s turning point is the key to the white function. White function has an important status in the grey system theory; at the same time, the determination of white function is one of the most critical links in the grey clustering evaluation, and is the key to from qualitative analysis to quantitative modelling. There are four basic forms for white function that are commonly used: typical white function, upper limit measure white function, lower measurement white function and moderate white function.

The key of white function is the determination of function’s turning point which reflects whether the determination of white function is scientific. Typical white function f(x) is the determination of starting point and ending point, the left is increasing function, and the right is decreasing function, if the white function f(x) has no the first and second turning point, it is the lower limit measure white function, if the second and third turning point of the white function f(x) is coincided, it is the moderate measure white function; if the white function f(x) has no the third and fourth turning point, it is the upper limit measure white function.

When we need to know about the position or level of an evaluation object in an index sample, we will need to use the grey clustering technology in grey system. Grey clustering technology is used to establish evaluation model, and the specific expression is as follows:

Evaluation model is expressed as: $PJ = (A, B, C)$, wherein $A = \{A_1, A_2, A_3,..., A_m\}$ is the evaluated object set; $B = \{B_1, B_2, B_3,..., B_n\}$ is the evaluation class set; $C = \{C_1, C_2, C_3,..., C_t\}$ is evaluation level.

For example, the object set A is consists of m students, and the single-class evaluation is conducted on n evaluation class, the result constitutes $B=\{B_1,B_2,B_3,...,B_t\}$, setting t evaluation levels $\{C_1,C_2, C_3,...,C_t\}$, it can be: excellent, good, qualified and unqualified, and so on.

In this model, each element of the evaluation level set C meets three features of the set element: certainty, namely, for an arbitrary element, it belongs to a particular set, or it does not belong to the set, it must meet one situation; inequality, namely, the elements in the same set are different from each other; disorder, namely, by changing the order of the elements in the set, these elements still belong to a set. Although each evaluation level in the set C meets the disorder and the position of each element in the set can be arbitrary, comprehensively, in terms of the whole set, each element in the set is in a certain order. Because the set C is a collection composed of multiple evaluation levels, and each element is the evaluation obtained according to the division of different grades, and each evaluation’s grade range has no intersection, therefore, the elements in the set which are classified within one range has no intersection or a continuous sub-range. Each element of the evaluation object set A in the model needs to satisfy the similarity principle, namely each element must be homogeneous, for example, when we undertake learning outcome assessment to students, we cannot classify sports students and national unified recruitment students in the same sample, because there is essential difference between. Through the model of make the evaluation result for the evaluation objects, it needs to satisfy the uniqueness, that is, an evaluation object can only correspond to one evaluation result. This model is equivalent to a mapping function, and satisfies the many-to-one mapping, for example, the result of multiple students on learning outcome assessment can be good, but a student cannot be both excellent and good on the evaluation result.

For the n single-class evaluation indexes, the index values are obtained by test; by constructing the white function, clustering analysis is conducted for m clustering objects (students), to determine the grey class that the clustering objects belong to among grey classes. m clustering objects are taken as $A_1, A_2, A_3,..., A_m$, the clustering index is $B_1, B_2, B_3,..., B_n$, the grey class is $C_1, C_2, C_3,..., C_t$.

Now, assume that the sample matrix of all object clustering for all indexes is $d$, thereby.

\[
 d = \begin{bmatrix}
 d_{11} & d_{12} & \cdots & d_{1n} \\
 d_{21} & d_{22} & \cdots & d_{2n} \\
 \vdots & \vdots & \ddots & \vdots \\
 d_{m1} & d_{m2} & \cdots & d_{mn}
\end{bmatrix}
\]

wherein, $d_{ij}$ is the sample value of the I clustering object $A_i$ on the j clustering on index $B_j$, $1<i<m, 1<j<n$, constructs the white function $f_{ik}, 1<i<m, 1<k<t$, $f_{ik}$ is the white function that the j index $B_j$ belongs to the k grey class.
Calculating grey vector:

\[ \sigma_i = (\sigma_{i1}, \sigma_{i2}, \ldots, \sigma_{im}), 1 \leq i \leq m \]  

(2)

The mapping \( F_{ik} \rightarrow \sigma_{ik} \) is called grey clustering, wherein

\[ \sigma_{ik} = \sum_{j=1}^{k} f_{jk}(d_{ij})\eta_{jk} \]  

(3)

\[ \eta_{jk} = \frac{\lambda_{jk}}{\sum_{j=1}^{k} \lambda_{jk}} \]  

(4)

3.2 Processing flow of comprehensive evaluation based on grey clustering

The steps for using the comprehensive evaluation model of learning effect based on grey clustering are as follows:

1. Select evaluation samples, determine the evaluation objects, expressed as \( A_1, A_2, A_3, \ldots, A_m \); determine the evaluation indexes, expressed as \( B_1, B_2, B_3, \ldots, B_n \); determine evaluation grey class, expressed as \( C_1, C_2, C_3, \ldots, C_t \).
2. According to the actual sample value, determine the sample matrix \( d = (d_{ij})_{mn} \), \( d_i \) is the sample value of the \( i \) clustering object \( A_i \) on the \( j \) clustering index \( B_j \).
3. Determine the evaluation grey class’s white function as the white function of the \( j \) a index \( B_j \) belonging to the \( k \) grey class.
4. Figure out the calibration clustering, \( \lambda_{jk} \) is the threshold of \( f_{jk} \), \( \eta_{ij} \) is the weight of the \( j \) index belong to the \( k \) clustering class.
5. Figure out grey clustering, \( f_{jk}(d_{ij}) \) is the white weight of the sample value \( d_{ij} \) belonging to the \( k \) grey class, comprehensively reflecting the weight of the \( i \) evaluation object belonging to the \( k \) grey class.
6. Figure out grey vector \( \sigma_i, \sigma_i = (\sigma_{i1}, \sigma_{i2}, \ldots, \sigma_{im}) \).
7. \( F(\sigma_i) = \max \sigma_i = \max \{\sigma_{i1}, \sigma_{i2}, \ldots, \sigma_{im}\} \), the \( i \) clustering object \( A_i \) belongs to the \( k^* \) grey class \( C_k \).

4. EXAMPLE ANALYSIS

4.1 Example profile

A class in Wuhan Institute of Physical Education is taken as the sample to select objects. There are 46 students, 1 class adviser, and 10 teachers in this class. Now, six students are randomly selected as the evaluation objects from this class; the questionnaire of “the survey on the comprehensive learning evaluation of sports students in the teaching mode of physical education” (appendix 1) is used to obtain the learning outcomes of the six evaluation objects. The class adviser, all the teachers, and the students are taken as questionnaire distributed objects; each time by 22 questionnaires, the information of an evaluation object is obtained, and the information of these six evaluation objects are gained 6 times. The content involved in the questionnaire is divided into four types, including 32, recycling 20 questionnaires, and the results of these 20 questionnaires are taken as the basis of data acquisition. The grade, performance of moral education, learning attitude and quality development are evaluated for these six students with the series number of 1, 2, 3, 4, 5, 6 respectively, and the results of the questionnaires on these four aspects are processed to get the sample data as shown in table 1.

The evaluation of the six students’ learning is made according to four grades, namely, excellent, good, qualified and unqualified. In the following, according to the different performance of students in the four aspects, the comprehensive analysis of students’ learning effect is made.

(1) according to the evaluation samples, determine the evaluation objects as \( A_1, A_2, A_3, A_4, A_5 \) with the corresponding number of 1, 2, 3, 4, 5, 6; Determine evaluation indexes as \( B_1, B_2, B_3, B_4 \), corresponding to student’s grade, performance of moral education, learning attitude and quality development; determine evaluation grey class as \( C_1, C_2, C_3, C_4 \), corresponding student’s learning effect as outstanding, good, qualified and unqualified.
(2), according to the actual sample value, as shown in table 1, to get the sample matrix $d$:

\[
\begin{pmatrix}
90.23 & 80.26 & 86.36 & 77.41 \\
86.12 & 65.23 & 85.29 & 78.54 \\
79.23 & 78.25 & 84.19 & 76.36 \\
91.25 & 59.69 & 52.36 & 85.26 \\
60.28 & 72.84 & 62.36 & 96.03 \\
74.23 & 83.26 & 82.69 & 65.23
\end{pmatrix}
\]

(3) Determine the white function of evaluation grey class $f(x)$, based on the experience of experts and relevant standards.

**Table 1** Single class evaluation results

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Student number</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Student achievement</td>
<td>90.36</td>
<td>85.36</td>
<td>78.36</td>
<td>95.36</td>
<td>59.36</td>
</tr>
<tr>
<td>Performance of moral education</td>
<td>82.31</td>
<td>66.35</td>
<td>77.34</td>
<td>85.36</td>
<td>78.45</td>
</tr>
<tr>
<td>Learning attitude</td>
<td>78.36</td>
<td>86.32</td>
<td>65.39</td>
<td>78.65</td>
<td>84.25</td>
</tr>
<tr>
<td>Diathesis developing</td>
<td>85.36</td>
<td>85.32</td>
<td>70.36</td>
<td>85.36</td>
<td>74.15</td>
</tr>
</tbody>
</table>

4.2 Result analysis

The evaluation results of the test in this study show, that some student has the excellent performance in an evaluation index of the learning outcome assessment system does not represent the student’s learning effect is excellent. For the number 2 student’s comprehensive ability is excellent, but his learning effect is just good. Therefore, considering comprehensive factors can more objectively reflect the overall learning effect of the evaluation objects. 20 students that are randomly selected from the class in which the six evaluation students are, all 10 teachers of this class and the class adviser constitute the comprehensive learning effect evaluation group. 31 evaluation group members respectively take the comprehensive evaluation of the six students, namely, evaluating students’ learning effect as excellent, good, qualified or not qualified; and when a result accounts for over 80% of the total number of evaluation people, the evaluation result is taken as the student’s evaluation reference result. According to the statistical results, it is shown in table 2.

**Table 2** Learning effect comprehensive performance results

<table>
<thead>
<tr>
<th>Student number</th>
<th>Good(%)</th>
<th>Find(%)</th>
<th>Qualified(%)</th>
<th>Unqualified(%)</th>
<th>Evaluation of the results(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>83.25</td>
<td>12.6</td>
<td>3.22</td>
<td>0</td>
<td>Good</td>
</tr>
<tr>
<td>2</td>
<td>9.36</td>
<td>87</td>
<td>3.25</td>
<td>0</td>
<td>Find</td>
</tr>
<tr>
<td>3</td>
<td>3.24</td>
<td>90.23</td>
<td>6.54</td>
<td>0</td>
<td>Find</td>
</tr>
<tr>
<td>4</td>
<td>83.57</td>
<td>9.36</td>
<td>3.45</td>
<td>3.25</td>
<td>Good</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>9.36</td>
<td>80.26</td>
<td>9.45</td>
<td>Qualified</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>0</td>
<td>87.36</td>
<td>12.36</td>
<td>Qualified</td>
</tr>
</tbody>
</table>

Experiments show that by using the grey clustering to conduct the comprehensive evaluation of physical education teaching, the evaluation index system is reasonable, the evaluation model is feasible and practical, and the evaluation results are basically in line with the objective conditions, which can play a good role in promoting student's learning. 22 questionnaires are sent to each of these six evaluation objects in this study, and 20 pieces are recycled to obtain the required information; the 32 questions in the questionnaire reflect all the content of the comprehensive evaluation index system of the learning effect. There is no specific requirement for the number of the questionnaire, and it is usually determined according to the size of the assessment project, which can be hundreds of thousands of copies or dozens of copies. Based on the comprehensive analysis of the existing researches on the learning effect evaluation, it is learned that the number of questionnaires are basically above 40, and can be up to 200, and the number of the questionnaire question is generally 40 to 80. With the contrast of the evaluation results of the model in this study, it can be concluded, under the condition that the sample data quantity is small, the evaluation results of the model are basically in line with the conclusion of the actual situation. Therefore, the overall evaluation scheme that this research puts forward is feasible and effective, and can be used in practice.
4.3 Monitored data for the supports of the foundation pit

The data monitored by the inclinometers on the side of the foundation pit near the high-rise building. A comparison of the monitored data with the simulated results obtained by the finite element model indicates that the results are similar. When the excavation of the foundation pit was at the bottom of piles, the monitored displacement was 31 mm as compared to the simulated displacement of 27.8 mm. This suggests that the analytical model and the selection of the constitutive relationship and parameters are suitable for producing reasonably conservative results.

5. CONCLUSION

This paper first introduces the implementation scheme design of the comprehensive evaluation of physical education, and then uses examples to verify the effect of the model constructed in this study, with the application of the traditional evaluation method, namely total score method into the practice to be analyzed by comparing with the model of this study. Through practical test, it is obtained that the evaluation index system in this study is basically scientific, reasonable and feasible, and the evaluation result is basically consistent with the actual situation, thus it verifies the conclusion that the model in the case of small sample can ensure the validity of the evaluation results.

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