Research on the comprehensive evaluation method of college students' achievements based on multi-view RSR

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Abstract. In view of the problems and shortcomings of the current college students' achievements evaluation methods, a multi-view rank sum ratio (RSR) comprehensive evaluation method of students' achievements was proposed. The method integrated the two factors of curriculum importance and students' learning ability when determining the weight. Then combined with the RSR ranking method, the comprehensive evaluation ranking of students' achievements was carried out. This method overcomes the subjectivity of weight setting and maximally reflects the integrity of information. Finally, through the empirical analysis, the method was compared with the average score method and intellectual education evaluation method, and the effectiveness of the method was verified through the ranking results comparison.

1. Introduction
Under the current education system, the commonly used talent evaluation mode is to evaluate the comprehensive quality of students according to the academic year. And the students' curriculum examination results are still the main digital indicators reflecting students' learning ability and teaching effect[1]. The students' curriculum examination results take a large proportion in the evaluation of students' comprehensive ability, which directly affects the effect of the evaluation. Therefore, it is extremely important to evaluate students' curriculum examination results in a fair, equitable, reasonable and scientific way.

At present, ranking students' achievements according to their total or average score is the most commonly used method in colleges. However, these two methods ignore the differences between different courses, different teachers, different classes, and different assessment methods. Therefore, the result of ranking is not fair and objective, and it can not evaluate the comprehensive ability of students scientifically. In view of this, many scholars put forward some comprehensive evaluation methods from the statistical point of view. According to the way of determining weight, there are two categories: one is subjective weighting method, such as AHP and fuzzy comprehensive evaluation[2,3]. The way of weight determination in subjective weighting method has certain subjectivity, which is greatly influenced by the personal preference or experience of experts. Therefore, the fair and objective principle in the achievements evaluation is not fully reflected. The other is objective weighting method, such as factor analysis method, clustering method and grey correlation method[4,5]. Although the objective weighting method reflects the objectivity in the way of weight determination, and has a good effect on the evaluation of students' comprehensive ability in some aspects, there are some loss of student achievement information during accurate evaluation.

Based on the existing research findings, this paper proposed a multi-view RSR method for students' achievements evaluation. Based on the RSR ranking method, a new way of determining the weight
was proposed, that is to say, the two factors of course importance (credits) and student learning ability (mean variance) were included in the weight calculation. On the one hand, this method overcomes the subjectivity of weight setting. On the other hand, it applies the advantage of RSR in ranking when ranking the students' achievements. It makes the comprehensive evaluation of students' achievements more scientific and fair.

2. Comprehensive Evaluation Method of College Students' Achievements Based on Multi-view RSR

2.1. Determination of Curriculum Weight Based on Credit and Mean Square Deviation

(1) The initial determination of credit system weight based on curriculum importance: Credit is a measurement unit used to calculate students' learning load[6]. Every course in the college has a certain credit. Only by passing the examination of this course can the student get the corresponding credits. Generally speaking, the higher the credit, the more hours the class is, the more important the course is, and the more it reflects the professional ability of the student. Therefore, this paper proposed to determine the course initial weight of each course based on its credits, specific steps: ① $m$ courses will be classified into several categories according to their credits, and the courses with the same credits are classified into one category; ② Calculate the total credits $S$ of $m$ courses; ③ Calculate the total credits $K_i$ ($1 \leq i \leq m$) of each category; ④ Calculate the proportion of total credits of each category in total credits of all courses, $W_i = K_i / S$, $W_i$ is the initial weight of each category.

(2) Revision of the mean variance weight based on the difficulty of the test paper: For a random variable, its variance reflects the dispersion degree of sample data to the mean[7]. Generally speaking, the more difficult the test paper is, the larger the variance of the score will be, and the greater amount of hidden information will be. Getting high score in a more difficult course should receive a relatively higher evaluation. The mean variance method is just based on this principle. On the basis of the initial weight, the weight of each course is modified according to the variance, specific steps: ① Calculate the variance of each course ($d_j$) and the total variance of the courses ($D_i$) in this category; ② Calculate the percentage of variance of each course in the total variance of the category courses, $p_j = d_j / D_i$; ③ Multiply the proportion of the course by the initial weight of the category courses, which is the final weight of the course, $w_j = p_j * W_i$.

2.2. Comprehensive Evaluation Method of Students' Achievements Based on RSR

The basic principle of RSR comprehensive evaluation method is to obtain dimensionless statistics $W_{RSR}$ through rank conversion in an m-row-n-column matrix. On this basis, the distribution of $W_{RSR}$ is studied by using the method of parameter statistical analysis. Then the $W_{RSR}$ value is used to rank the evaluation objects directly or into different grades, so as to make a comprehensive evaluation of the evaluation objects[8].

The steps of RSR comprehensive evaluation method are as follows:

① Coding the ranking. The $m$ evaluation indicators (courses) and $n$ evaluation objects (students) are arranged into an original data table of $n$ rows and $m$ columns. According to the score of the course, the ranking of each evaluation object of each indicator is coded from small to large. The ranking matrix is recorded as $R = (R_{ij})_{n \times m}$.

② Calculating the weighted RSR ($W_{RSR}$). The calculation formula is $W_{RSR} = \frac{1}{n} \sum_{j=1}^{m} w_j R_{ij}$, $w_j$ is the weight of the j-th evaluation indicator, the weight is calculated using the method described in Section 2.1, and $\sum_{j=1}^{m} w_j = 1$. 


③ Calculating the probability unit. Arrange the $WRSR$ value from small to large, and list the frequency ($f_i$) of each group. Calculate the cumulative frequency ($cf_i$) of each group. Calculate the cumulative probability of each group, $p_i = cf_i / n$. Convert $p_i$ to probability unit $Probit_i$, $Probit_i$ is the $p_i$-quantile of the standard normal distribution plus 5.

④ Calculating the linear regression equation. Taking the probability unit $Probit_i$ corresponding to the cumulative frequency as the independent variable and the $WRSR$ value as the dependent variable, the linear regression equation is calculated, that is $WRSR = a + b \times Probit_i$

⑤ Sorting into ranks. According to the estimated value of $P$ which is calculated by regression equation, the evaluation objects are sorted into ranks.

3. Empirical Analysis
This research took the sophomore course examination results of 57 students majoring in information management and information system as the research object, and completed the statistical analysis and modeling process of the entire subject.

3.1. Data collection and preprocessing
The examination results of 57 students majoring in information management and information system were collected through the school's educational administration system. Because the names of some courses are too long and inconvenient for statistics arrangement, the course names are renumbered and the results are shown in Tab.1.

| course name                  | new coding | course name                  | new coding | course name                      | new coding |
|------------------------------|------------|------------------------------|------------|----------------------------------|------------|
| Physical Education 1         | C1         | College English              | C2         | Discrete Mathematics             | C3         |
| Basic Accounting             | C4         | Data Structure               | C5         | Microeconomics                   | C6         |
| Outline of Modern Chinese History | C7         | Physical Education 2        | C8         | College EnglishA4                | C9         |
| Computerized Accounting      | C10        | Computer Network             | C11        | Data Structure Course Design     | C12        |
| Theoretical System of Socialism with Chinese Characteristics | C13       | Principle and Application of Database | C14       | Database Principle and Application Course Design | C15       |

According to the needs of the research, the format and type of data were transformed, and the corresponding processing of outliers, extreme values and missing values were carried out. The data cleaning process included: filling in missing data values, smoothing noisy data, identifying or removing outliers, and resolving inconsistencies. Data conversion were mainly to convert the format and type of the data, such as converting continuous data into discrete data, or converting discrete data into continuous data. Part of the arranged data was shown in Table 2.

| ID  | C1  | C2  | C3  | C4  | C5  | C6  | C7  | C8  | C9  | C10 | C11 | C12 | C13 | C14 | C15 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1   | 90  | 87  | 88  | 93  | 92  | 94  | 79  | 91  | 91  | 95  | 73  | 85  | 90  | 98  | 95  |
| 2   | 67  | 71  | 55  | 61  | 60  | 86  | 66  | 92  | 72  | 90  | 82  | 65  | 78  | 87  | 65  |
3.2. Basic statistical description and analysis of students' achievement
By means of SPSS software, the basic statistical description and analysis of students' achievement were carried out. According to the data characteristics, the corresponding statistical description indicators and statistical graphs were selected to investigate the distribution and characteristics of the data. It mainly involved the concentration trend, dispersion degree and distribution state of data. Indicators included average score, standard deviation, skewness, kurtosis, etc[9].

| Tab.3  Data statistical description |
| course | average score | standard deviation | skewness | kurtosis |
|--------|---------------|---------------------|----------|----------|
| C1     | 80.82         | 9.871               | -.339    | -.691    |
| C2     | 76.40         | 6.242               | -.626    | -.028    |
| C3     | 72.39         | 9.973               | -.351    | .771     |
| C4     | 70.93         | 12.753              | -.181    | -.182    |
| C5     | 77.51         | 14.232              | -.610    | .184     |
| C6     | 74.28         | 10.683              | -.314    | -.381    |
| C7     | 74.32         | 5.711               | .940     | .422     |
| C8     | 83.72         | 7.406               | -.331    | -.205    |
| C9     | 78.47         | 6.582               | -.313    | .028     |
| C10    | 88.35         | 7.461               | -.633    | 2.446    |
| C11    | 79.51         | 8.496               | .743     | -.169    |
| C12    | 75.88         | 7.387               | .134     | -.461    |
| C13    | 82.23         | 7.462               | -.416    | .665     |
| C14    | 79.05         | 10.557              | -.231    | -.934    |
| C15    | 81.14         | 9.403               | -.209    | -.778    |

According to Tab.3, the average score of most courses are between 70 and 80, and the courses with higher average scores mostly are practical courses that do not use the paper examination, such as physical education and curriculum design. The standard deviation of most courses is within 10, indicating that the data dispersion is normal. The skewness and kurtosis coefficients of most courses...
are not much different from 0, indicating that the data distribution is normal.

In order to further analyze whether there is a certain correlation between course scores, Pearson correlation coefficient was used to examine the correlation between courses[10]. The results were shown in Tab.4.

Tab.4 Course correlation coefficient

|      | C2   | C3   | C4   | C5   | C6   | C7   | C9   | C10  | C11  | C13  | C14  |
|------|------|------|------|------|------|------|------|------|------|------|------|
| C2   | 1    | .388'' | .525'' | .382'' | .496'' | .0204 | .668'' | .289'' | .0244 | .289'' | .412'' |
| C3   | .388'' | 1    | .713'' | .767'' | .453'' | .0263 | .499'' | .564'' | .423'' | .326'' | .516'' |
| C4   | .525'' | .713'' | 1    | .675'' | .594'' | .457'' | .0606 | .409'' | .549'' | .671'' | .516'' |
| C5   | .382'' | .767'' | .675'' | 1    | .536'' | .385'' | .541'' | .504'' | .397'' | .398'' | .560'' |
| C6   | .496'' | .453'' | .594'' | .536'' | 1    | .419'' | .480'' | .0247 | .329'' | .478'' | .675'' |
| C7   | 0.204 | .263   | .457'' | .385'' | .419'' | 1    | .510'' | .0118 | .295'' | .583'' | .451'' |
| C9   | .668'' | .499'' | .606'' | .541'' | .480'' | .510'' | 1    | .0197 | .514'' | .531'' | .447'' |
| C10  | .289'' | .564'' | .636'' | .504'' | .0247 | .0118 | .412'' | 1    | .293'' | .382'' | .447'' |
| C11  | 0.244 | .423   | .409'' | .397'' | .329'' | .295'' | .0197 | .293'' | 1    | .301'' | .430'' |
| C12  | .289'' | .326   | .549'' | .398'' | .478'' | .583'' | .514'' | .382'' | .301'' | 1    | .530'' |
| C13  | 0.412'' | .516   | .671'' | .560'' | .675'' | .451'' | .531'' | .447'' | .430'' | .530'' | 1    |

* indicate a significant correlation at the 0.05 level.** indicate a significant correlation at the 0.01 level.

It can be seen from Tab.4 that the results of most courses are significantly related, among which the results of basic accounting courses are highly correlated with other courses, and the computer network course scores are relatively low correlated with other courses.

The results of the above analysis show that the collection of students' achievement can reflect the students' mastery of the curriculum. Therefore, the Multi-view RSR method can be used in the evaluation of students' achievement.

3.3. Establishment of comprehensive evaluation model of students' achievement
(1) Determination of weight
This paper determined the weight of curriculum from two aspects: on the one hand, from the perspective of curriculum importance, the initial weight of each curriculum were determined based on the credit system. On the other hand, from the perspective of difficulty of curriculum test paper, the weights of the courses were revised based on the variance. The results are shown in Tab.5

Tab.5 Course weight

| course | credit | category total credits | category weights | variance | category total weights | variance weights | final weight |
|--------|--------|------------------------|------------------|----------|------------------------|-----------------|-------------|
| C1     | 1.00   | 4                      | 0.095            | 97.43    | 295.26                 | .3300           | 0.0313      |
| C12    | 1.00   |                        |                  | 54.57    |                        | .1848           | 0.0176      |
| C8     | 1.00   |                        |                  | 54.85    |                        | .1858           | 0.0176      |
| C15    | 1.00   |                        |                  | 88.41    |                        | .2994           | 0.0284      |
| C7     | 1.50   | 1.5                    | 0.0357           | 32.61    |                        | 1.0000          | 0.0357      |
| C9     | 3.00   | 3                      | 0.0714           | 43.33    |                        | 1.0000          | 0.0714      |
| C4     | 3.50   | 17.5                   | 0.417            | 162.64   |                        | .3256           | 0.1358      |
| C10    | 3.50   |                        |                  | 55.66    |                        | .1114           | 0.0465      |
(2) Establishment of the model
On the basis of the weight had been determined, the RSR method would be used to establish the comprehensive evaluation model of students' performance. According to the steps of RSR evaluation method mentioned in section 1.2, the result of coding the ranking, calculating weighted RSR (WRSR) and calculating probability unit were showed in table 6. Taking the WRSR as independent variable and Porbit as independent variable, the regression equation was established. The results were shown in the Tab.7.

| ID | C1  | C2  | C3  | C4  | C5  | C6  | C7  | C8  | C9  | C10 | C11 | WRSR | Probit |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|
| 1  | 45.5| 57.0| 53.0| 56.0| 47.5| 57.0| 49.0| 46.5| 55.5| 49.5| 10.0| 49.5  | 56.5  | 0.86578| 7.10734|
| 2  | 7.5 | 10.5| 3.0 | 10.5| 5.0 | 48.0| 1.5 | 50.5| 10.0| 27.0| 38.5| 6.5   | 55.5  | 0.31870| 4.25478|
| 3  | 4.5 | 24.5| 27.0| 32.0| 14.0| 27.0| 43.5| 31.5| 17.0| 49.5| 10.0| 27.0  | 9.5   | 0.38040| 4.47055|
| 4  | 14.5| 25.5| 15.0| 37.0| 29.0| 50.0| 32.5| 54.0| 17.0| 34.0| 17.5| 27.0  | 19.0  | 16.5  | 0.51713| 5.11016|
| 5  | 21.5| 42.5| 37.5| 53.0| 29.0| 9.5 | 49.0| 18.0| 55.5| 53.5| 1.0 | 27.0  | 29.0  | 22.0  | 16.5  | 0.56276| 5.24428|
| 6  | 45.5| 48.0| 57.0| 56.0| 57.0| 50.0| 52.0| 53.0| 57.0| 57.0| 57.0| 57.0  | 57.0  | 53.0  | 0.96329| 7.61973|
| 7  | 17.5| 42.5| 46.0| 43.0| 35.0| 44.5| 46.5| 15.5| 41.5| 27.0| 24.5| 27.0  | 43.5  | 16.5  | 0.67615| 5.68836|
| 8  | 42.0| 15.0| 4.0 | 10.5| 5.0 | 5.0 | 36.5| 1.0 | 26.5| 9.0  | 32.5| 6.5   | 45.5  | 7.5   | 36.0  | 0.25971| 3.92126|
| 9  | 30.5| 50.5| 50.0| 57.0| 43.0| 53.5| 40.0| 39.5| 53.5| 53.5| 49.5| 49.0  | 22.0  | 31.0  | 36.0  | 0.80246| 6.47449|
| 10 | 1.5 | 7.0 | 22.5| 2.0 | 25.5| 13.5| 10.0| 2.0 | 14.5| 7.0 | 17.5| 27.0  | 3.0   | 2.0   | 16.5  | 0.22578| 3.83893|
| 11 | 51.5| 25.5| 56.5| 48.0| 53.0| 53.5| 54.0| 44.0| 38.0| 34.0| 49.5| 49.0  | 48.0  | 55.0  | 36.0  | 0.85526| 6.81078|
| 12 | 26.5| 29.0| 13.5| 20.5| 16.5| 31.0| 56.0| 9.5 | 51.0| 21.5| 24.5| 27.0  | 51.0  | 24.0  | 36.0  | 0.46436| 4.97801|
| 13 | 19.5| 15.0| 31.5| 18.0| 29.0| 16.0| 18.0| 31.5| 10.0| 34.0| 24.5| 27.0  | 36.5  | 22.0  | 4.5   | 0.40162| 4.66396|
| 14 | 30.5| 48.0| 35.0| 39.0| 31.5| 52.0| 22.5| 15.5| 34.5| 27.0| 24.5| 27.0  | 36.5  | 44.5  | 52.5  | 0.63601| 5.43073|
| 15 | 30.5| 29.0| 51.0| 18.0| 50.5| 31.0| 27.5| 46.5| 14.5| 40.5| 54.0| 49.0  | 22.0  | 35.5  | 52.5  | 0.64032| 5.47951|
| 16 | 42.0| 50.5| 44.5| 51.5| 43.0| 43.0| 40.0| 31.5| 31.5| 46.0| 49.5| 27.0  | 55.0  | 28.5  | 16.5  | 0.73946| 6.16107|
| 17 | 57.0| 9.0 | 22.5| 10.5| 22.5| 7.0 | 18.0| 5.0 | 20.5| 17.5| 32.5| 27.0  | 7.5   | 39.0  | 16.5  | 0.36070| 4.41924|
| 18 | 14.5| 42.5| 31.5| 24.0| 20.0| 37.5| 43.5| 56.0| 34.5| 12.0| 49.5| 27.0  | 29.0  | 37.0  | 36.0  | 0.53653| 5.19920|
| 19 | 4.5 | 19.0| 44.5| 29.0| 50.5| 27.0| 18.0| 23.0| 53.5| 53.5| 41.5| 49.0  | 29.0  | 35.5  | 36.0  | 0.65787| 5.58076|
| 20 | 26.5| 12.5| 48.0| 22.5| 36.0| 46.5| 36.5| 18.0| 41.5| 40.5| 24.5| 27.0  | 39.5  | 49.5  | 36.0  | 0.63029| 5.38295|
According to Tab.7, the regression equation is as follows:

\[ W_{RSR} = -0.535 + 0.207 \times \text{Probit} \]  

The estimated value (WRSRF) corresponding to each student's \( W_{RSR} \) was calculated according to the regression equation. Then the evaluation objects were ranked according to the WRSRF value, and the results were shown in Tab.8.

(3) Evaluation of the model

In order to verify the evaluation effect of the model, the ranking results obtained by the model were compared with the results of the average score method and the results of the intelligent education evaluation method. The average score method is to rank according to the average score of all compulsory courses. The intelligent education evaluation method is used to evaluate student achievements in our school currently, it is a comprehensive evaluation of all compulsory courses (except physical education) and elective courses setted in the students' teaching plan. These three methods were used to rank the student achievements, the results were shown in Tab.9
Tab.9 Comparison of ranking results of three methods

| ID | average score method | intellectual education evaluation method | RSR | ID | average score method | intellectual education evaluation method | RSR |
|----|----------------------|------------------------------------------|-----|----|----------------------|------------------------------------------|-----|
| 1  | 12                   | 3                                        | 2   | 30 | 28                   | 49                                        | 55  |
| 2  | 7                    | 33                                       | 45  | 31 | 23                   | 24                                        | 23  |
| 3  | 24                   | 31                                       | 41  | 32 | 8                    | 57                                        | 57  |
| 4  | 4                    | 25                                       | 27  | 33 | 27                   | 9                                         | 7   |
| 5  | 41                   | 34                                       | 24  | 34 | 35                   | 12                                        | 9   |
| 6  | 6                    | 4                                        | 1   | 35 | 48                   | 26                                        | 29  |
| 7  | 51                   | 19                                       | 15  | 36 | 21                   | 7                                         | 12  |
| 8  | 16                   | 53                                       | 50  | 37 | 1                    | 1                                         | 6   |
| 9  | 33                   | 5                                        | 5   | 38 | 30                   | 17                                        | 26  |
| 10 | 57                   | 37                                       | 51  | 39 | 44                   | 36                                        | 39  |
| 11 | 5                    | 2                                        | 3   | 40 | 17                   | 6                                         | 4   |
| 12 | 37                   | 38                                       | 30  | 41 | 46                   | 51                                        | 54  |
| 13 | 25                   | 44                                       | 37  | 42 | 19                   | 29                                        | 32  |
| 14 | 38                   | 15                                       | 20  | 43 | 36                   | 18                                        | 13  |
| 15 | 9                    | 20                                       | 19  | 44 | 11                   | 16                                        | 14  |
| 16 | 26                   | 23                                       | 8   | 45 | 31                   | 52                                        | 52  |
| 17 | 20                   | 30                                       | 42  | 46 | 53                   | 27                                        | 44  |
| 18 | 2                    | 39                                       | 25  | 47 | 47                   | 43                                        | 48  |
| 19 | 34                   | 21                                       | 17  | 48 | 49                   | 10                                        | 10  |
| 20 | 39                   | 13                                       | 21  | 49 | 42                   | 47                                        | 38  |
| 21 | 15                   | 40                                       | 47  | 50 | 22                   | 32                                        | 34  |
| 22 | 45                   | 35                                       | 46  | 51 | 40                   | 30                                        | 40  |
| 23 | 55                   | 42                                       | 36  | 52 | 32                   | 33                                        | 35  |
| 24 | 52                   | 48                                       | 53  | 53 | 50                   | 19                                        | 18  |
| 25 | 14                   | 28                                       | 28  | 54 | 54                   | 53                                        | 56  |
| 26 | 18                   | 41                                       | 33  | 55 | 3                    | 43                                        | 43  |
| 27 | 10                   | 22                                       | 16  | 56 | 56                   | 40                                        | 49  |
| 28 | 13                   | 46                                       | 31  | 57 | 43                   | 20                                        | 22  |
| 29 | 29                   | 11                                       | 11  |    |                      |                                            |     |

It can be obtained from Tab.9 that the results of the multi-view RSR method is closer to the results of the intellectual education evaluation method, but it is quite different from the evaluation results of the average score method. This also shows that in the case of a small number of courses, it is not fair and objective to evaluate students' achievement only with the average score. Although the intellectual education evaluation method is based on average scores, but due to the large number of courses involved, it can also reflect the students' intellectual education results to a certain extent. The advantage of the multi-view RSR method proposed in this paper is that it not only considered the importance of the course, but also considered the difficulty of the course. In addition, this method breaks the limitation of the traditional evaluation method on the number of courses. No matter the number of courses is large or small, it is fully applicable.

4. Summary and Conclusions
This paper first analyzes the existing student performance evaluation methods and summarizes the
limitations of various methods. Then combined with the actual curriculum assessment situation, the multi-view RSR method of comprehensive evaluation of students' performance was proposed. This method considered the importance of course and difficulty of the course test when determining the curriculum weight, and combined with the advantages of RSR in ranking, this method can evaluate students' comprehensive achievement more objectively and fairly. It is more suitable for the more accurate comprehensive evaluation of students' achievement required in the award evaluation.

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