Statistical Model of Online Educational Resource Allocation for Coordinated Development of Regional Economy

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Abstract. In order to improve the statistical ability of online education allocation resources, a statistical model of online education allocation resources for the coordinated development of regional economy is proposed. Based on the principle of comparability and practicability in the selection of statistical indicators of online education allocation resources, this paper constructs a statistical indicator system of online education allocation resources, assigns the weight of statistical indicator system of online education allocation resources by using the specific steps of analytic hierarchy process, and calculates the allocation level of educational resources of each school in six administrative regions by using the weighted index and model, According to the results of the cluster analysis of the types of school resource allocation, by introducing the difference coefficient, the balance of the allocation of various types of school education resources in the region is determined. Through the establishment of the statistical model of online education resource allocation, the statistics of online education resource allocation is realized. The experimental results show that the statistical model of online education resource allocation for the coordinated development of regional economy has relatively high statistical ability in terms of statistical efficiency and student satisfaction.

Keywords: Coordinated development of regional economy · Online education · Resource allocation · Statistical model

1 Introduction

The allocation of online resources refers to the optimal allocation of online resources, that is, to achieve the relative balance of market supply and demand by reasonable allocation of limited online resources, thus achieving sustainable economic development. The theory of optimal allocation of online resources holds that if the contradiction between the limited resources we have and can use and the unlimited demand for them can not be solved reasonably, human resources can not be used sustainably. Therefore, limited resources should be allocated to all levels of society in a reasonable proportion, and this kind of allocation can achieve the maximum use of resources. The theory of

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optimal allocation of resources plays an important role in the process of social and economic development, so its essence has been constantly used for reference by other disciplines.

Statistics of online educational resources allocation is an important part of educational resources management in colleges and universities. It plays an important role in organization adjustment, education integration, curriculum design, subject construction and faculty construction. At present, online educational resources allocation statistics in colleges and universities is mainly based on the collection of basic information of various disciplines, and the establishment of online educational resources allocation files to meet the needs of filling in various statistical forms. The main body of the statistics of online education allocation resources in colleges and universities includes full-time teachers, scientific researchers, managers, teaching assistants and logistics staff.

The statistical difference of online educational resources allocation refers to the different treatment due to the individual situation of the educatees. The main idea is that the distribution and statistics of educational resources are not determined entirely by the average value. When designing the statistical model of online educational allocation resources, the statistics of resources is only considered in the quantity of educational allocation resources, but not in the interest of the educatees. In fact, the difference of online education allocation resources in the process of statistics and the different needs of individuals have become an important aspect of online education allocation resources statistics. It is necessary to recognize the difference of individual needs in different education when we study the basic theory and design the statistical model of online education allocation resources. Based on this, the society must be able to provide a variety of types and channels of educational resources to facilitate the individual education to choose, but also must respect the individual education. Although the diversity of educational resources in a certain level of performance differences, but each individual's personality and endowment of education has been free and adequate development, which also reflects the fairness from another level. Educational equity envisages the differences between the educated individuals, and abandons the mechanistic requirement for educational equality. On the one hand, it requires that both the educated individual and the educated individual receive the education that best suits them, which reflects both equality and difference. Since there are differences among the educated individuals, the allocation of educational resources should also reflect the differences, such as differences in school types, curriculum, or even teaching methods. Homogeneous education neglects the particularity of the educated individual and hinders the all-round development of the individual. Therefore, the concept of diversity and diversity must be upheld in the sustainable development of education [1–6].

Since the beginning of this century, the fair development of education in our country has made a big breakthrough. However, there is still a big gap between online and offline education quality and allocation of educational resources due to scientific and technological development. Under this background, many scholars have carried out the research on the unbalanced allocation of online education resources. According to the different types of online education resources, the statistics of online education resources is made, which greatly improves the satisfaction of students in the process of online education resources.

Based on the above research background, this paper designs a statistical model of online educational resources allocation. The innovation of the model lies in the cluster analysis of the types of school resources allocation. By introducing the coefficient of difference, the balance of regional educational resources allocation is judged and the balance of allocation is improved.

2 Design of Statistical Model of Online Education Allocation Resources

2.1 Construct the Statistical Index System of Online Education Allocation Resources

According to the scientificity and conciseness of the selection of statistical indicators, this paper omits or merges the indicators; according to the comparability and practicability principles of index selection, the indicators should be converted into relative values that can be compared, so the original statistical indicators should be transformed into relativity [7], and the specific meaning is shown in Table 1.

Table 1. Comparable composite indexes and their meanings

Index	Meaning	Index	Meaning
Average number of students in a class	Total number of students/total number of classes	Number of teaching computers for 100 students	Total number of teaching computers/total number of students * 100
Average value of fixed assets per student	Total fixed assets/total number of students	Average student's investment in informatization in last academic year	Total investment in informatization in last academic year/total number of students
Average floor area per student	Total school area/total number of students	Average stadium area per student	Total area of school sports venues/total number of students
Number of multimedia seats for 100 people	Total number of multimedia seats/total number of students * 100	Average area of teaching and auxiliary rooms per student	Total area of teaching and auxiliary rooms/total number of students
Average book collection per student	Total collection of general books/total number of students	E-book collection per student	Total collection of e-books/total number of students

(*continued*)

Table 1. (*continued*)

Index	Meaning	Index	Meaning
Teacher student ratio	Total number of full-time teachers/students	Proportion of teachers with intermediate and above titles	Total number of teachers with intermediate title or above/total number of full-time teachers
Proportion of teachers with bachelor degree or above	Total number of teachers with bachelor degree or above/total number of full-time teachers	Proportion of full-time teachers receiving information training	Number of full-time teachers receiving information training/total number of full-time teachers
Public funds per student	Total public expenditure/total students	Education funds per student	Total expenditure on education/total number of students

According to the availability and practicability of the index selection, through certain analysis, the index system composed of the following three levels and 16 composite indicators is formed to count the resource allocation level of online education.

According to the scientificity and conciseness of the statistical index selection, the indicators are omitted or merged, and the statistical index system of online education allocation resources is constructed by using the comparability and practicability principles of index selection.

2.2 Assignment of Weights of Statistical Index System of Online Education Allocation Resources

The analytic hierarchy process (AHP) is used to assign the weight of the statistical index system of online education allocation resources. The specific steps are as follows:

Step 1: Establish system hierarchy
Before determining the weight of the evaluation factors of the comprehensive allocation level of school basic education, it is necessary to arrange the target levels of each evaluation factor, and establish a systematic hierarchy structure, which includes three levels: target level (a), criterion level (b) and index level (c).
Step 2: Construct judgment matrix
Each element of each layer is compared with each other, and the more important judgment can be given to each factor. Then, all the judgments are represented by relevant values, so as to form a judgment matrix and assign certain values to the importance.
Step 3: Hierarchical single sort
Hierarchical single ranking refers to the ranking of the importance of each factor in the upper level. The square root method is used to calculate the maximum eigenvalue and

its corresponding eigenvector [8], and the calculation process is as follows:

$$M_i = \prod_{j=1}^{n} \alpha_{ij}, \quad i = 1, 2, \ldots, n \tag{1}$$

Where, *CV* represents the difference coefficient, *MN* is the average value of statistical indicators and *SD* is the standard deviation of statistical indicators

$$\overline{W}_i = \sqrt[n]{M_i} \tag{2}$$

$$W_i = \frac{\overline{W}_i}{\sum_{j=1}^{n} W_j} \tag{3}$$

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(Aw)_i}{nW_i} \tag{4}$$

Step 4: Consistency test of judgment matrix
The consistency of the above results was tested, and the test formula was as follows:

$$CI = \lambda_{\max} - \frac{\mathrm{n}}{n-1} \tag{5}$$

$$CR = \frac{CI}{RI} \tag{6}$$

After each step of analytic hierarchy process, the final determined weight value is shown in Table 2.

Using the specific steps of the analytic hierarchy process, the weight of the online education resource allocation statistical index system is assigned.

2.3 Analyze the Balance of Online Education Resources Allocation

After constructing the statistical index system of online education allocation resources, it is necessary to make a balanced analysis on the allocation of online education resources of various schools under the background of coordinated development of regional economy.

The general distribution of data from the following three aspects is often studied. The first aspect is the concentration trend of data, focusing on the size of the aggregation of data and its central value; the second aspect is the discrete trend of data, focusing on the size of the dispersion of data and its central value; the third aspect is the skewness and kurtosis of data, mainly analyzing the shape of data distribution. The imbalance mentioned in this paper refers to the size of the difference between things, that is, whether the dispersion of data exceeds a certain degree, so the size of the dispersion between data can be used to judge the balance or imbalance between things [9].

There are many methods to measure the dispersion degree of numerical data in statistics. In this paper, combined with the previous research and the actual situation,

Table 2. Weight of statistical index system of online education resources

Indicator name	Weight value	Indicator name	Weight value
Average number of students in a class	0.1170	Number of teaching computers for 100 students	0.0623
Average value of fixed assets per student	0.0934	Average student's investment in informatization in last academic year	0.0614
Average floor area per student	0.0257	Average stadium area per student	0.0276
Number of multimedia seats for 100 people	0.0207	Average area of teaching and auxiliary rooms per student	0.0479
Average book collection per student	0.0385	E-book collection per student	0.0230
Teacher student ratio	0.0859	Proportion of teachers with intermediate and above titles	0.0584
Proportion of teachers with bachelor degree or above	0.0778	Proportion of full-time teachers receiving information training	0.0243
Public funds per student	0.1387	Education funds per student	0.0974

we choose standard deviation and difference coefficient to study the balance of the comprehensive level of primary and junior high school education resources allocation in six districts. If the unit of measurement is the same as that of the average, the standard deviation can be directly used for comparison. However, if the unit is different from that of the average, the standard deviation is not suitable for the difference degree of the comparative data, but the ratio between the standard deviation and the average should be used for comparison, which is the coefficient of difference. When we study the degree of difference, the standard deviation is absolute, while the coefficient of difference is relative. Obviously, when we study the difference of things, we can't simply rely on the standard deviation to judge. The coefficient of difference can eliminate the influence of different units or different averages on the comparison of differences between two or more samples, so the relative difference can better reflect the real situation of equilibrium. In this paper, the difference coefficient representing the relative difference is used as the index of equilibrium analysis.

In statistics and probability, the coefficient of difference is often called "coefficient of variation", "coefficient of dispersion" and "coefficient of standard deviation". It is a normalized measure of the dispersion degree of probability of data distribution. It is defined as the ratio of standard deviation to average value. The coefficient of difference is valid only when the average value of data is not equal to zero, and generally the average value applicable to data is positive However, the calculation process and results

of the comprehensive level of educational resource allocation in this paper meet the applicability of the difference coefficient. The difference coefficient is calculated as follows:

$$CV = \frac{SD}{MN} \tag{7}$$

Where, MN represents the average value of statistical indicators, and SD represents the standard deviation of statistical indicators.

$$SD = \sqrt{\sum_{i}^{n} \frac{MN_i - MN^2}{n}} \tag{8}$$

Among them, MN_i represents the comprehensive allocation level of educational resources in each school, MN represents the average value of the comprehensive allocation level of educational resources in primary or junior high schools in a district, and represents the number of primary schools or junior high schools in a district.

The larger the difference coefficient is, the greater the difference between the research objects is; the smaller the difference coefficient is, the smaller the difference between the research objects is. In this paper, the larger the value of the difference coefficient, the more unbalanced the comprehensive level of the regional primary or junior high school education resources allocation; the smaller the value of the difference coefficient, the more balanced the comprehensive level of the regional primary or junior high school education resource allocation [10–12].

In order to more intuitively judge the balance of the comprehensive level of primary and junior high school education resources allocation in six districts, this paper uses the model to calculate the equilibrium index of different periods of social development according to the general understanding of the regional economic and educational development status, and through expert consultation and reference to previous research results [13–15], and taking into account the nonlinear characteristics of the gradual gradual increase of the index level The following recommended criteria are obtained for the values that should be reached, as shown in Table 3.

Table 3. Evaluation criteria of educational resources balance

Difference coefficient standard	2005–2010	2010–2015	2015–2020
Ideal standard	0.250	0.157	0.125
Good standards	0.300	0.188	0.150
Basic standards	0.350	0.219	0.175

Using the weighted index and model to calculate the allocation level of educational resources of each school in the six administrative regions. cluster analysis is conducted on the types of school resources allocation according to the results, and the balance of educational resources allocation of various schools in the region is determined by the coefficient of difference.

2.4 Establish Statistical Model of Online Education Allocation Resources

If there are $n(n \geqslant 1)$ schools in a certain area, the education resources owned by the first school are $x_i(1, i, n)$, and the corresponding number of students is $s_i(1, i, n)$. The value of educational resources owned by all school students in the whole region is $-\frac{\sum_{i=1}^{n} x_i}{\sum_{j=1}^{n} s_j}$, and the educational resources possessed $\overline{x_1} \cdots \overline{x_n}$ by the corresponding students of each school will be sorted from small to large after making a difference. The difference coefficient of average student resources among schools is as follows:

$$V = \frac{\sqrt{\frac{\sum_{i=1}^{n} (\overline{x}_i - \overline{x})^2 \times s_i}{n}}}{\overline{x}} \tag{9}$$

Suppose that the educational resources to be allocated to each school are as follows R: the first school should achieve the same average student resources D_1 as the second school, $\overline{x}_i'$ and $\overline{x}$ the second school should achieve the same average student resources D_2 as the third school, then:

$$D_i = (\overline{x_{i+1}} - \overline{x_i}) \times s_i, (n-1) \tag{10}$$

The resources allocated to the i school are:

$$S_{D_i} = \sum_{i=1}^{n-1} D_i \tag{11}$$

At that time, $R = S_{D_k}, (1, k, n-1)$ the online education resources allocated by the first to the k schools were as follows:

$$\begin{cases} R_1 = (\overline{x}_{k1} - \overline{x_1}) \times s_1 \\ R_2 = (\overline{x_{h1}} - \overline{x_2}) \times s_2 \\ \cdots \\ R_k = (\overline{x_{h1}} - \overline{x_k}) \times s_k \end{cases} \tag{12}$$

Because $\overline{x}_n > \cdots > \overline{x_{k+1}} > \overline{x_k} > \cdots > \overline{x_2} > \overline{x_1}$, the demand of the n school for online education resources is less than that of the first school, in this case, the amount R can only meet the demand of the first to the first school. Therefore, through the regulation of the county (District) government, the average level x of educational resources of $k+1$ school is unified to the n average level of the county (District), while the first school does not allocate educational resources.

At that time, $S_{D_k} < R < S_{D_{k+1}}, (1, k, n-2)$ the total number of students from the first school to the k school was $S_k' = \sum_{i=1}^{k} S_i$, and the additional average student resources

$x'_k = \frac{(R-S_{Dh})}{S'_k}$, then the resources allocated by the first to the k school were as follows:

$$\begin{cases} R_1 = \left(\overline{x_{k+1}} - \overline{x_1} + x'_k\right) \times s_1 \\ R_2 = \left(\overline{x_{k+1}} - \overline{x_2} + x'_k\right) \times s_2 \\ \cdots \\ R_k = \left(\overline{x_{k+1}} - \overline{x_k} + x'_k\right) \times s_k \end{cases} \tag{13}$$

In this case, the amount R can only meet the needs of the first to the k school, and there is still a surplus, but the surplus can not meet the needs of the $k + 1$ school. Therefore, through the regulation of the district and county government, the average level of educational resources per student in k school is approached to the value of the regional average level, and the remaining amount x after distribution is evenly distributed to The number of students allocated to all schools is not allocated. $k + 1$ Schools to n do not allocate resources.

At that time $R \geqslant S_{D_{n-1}}$, the total number of students in the first to the $n - 1$ schools was as follows:

$$S_n = \sum_{i=1}^{n-1} S_i \tag{14}$$

The extra resources per student were as follows:

$$x'_n = \frac{\left(R - S_{D_{n-1}}\right)}{S'_n} \tag{15}$$

Then 1 to n the resources allocated to the school are:

$$\begin{cases} R_1 = \left(\overline{x_n} - \overline{x_1} + x'_n\right) \times s_1 \\ R_2 = \left(\overline{x_n} - \overline{x_2} + x'_n\right) \times s_2 \\ \cdots \\ R_k = x'_n \times s_n \end{cases} \tag{16}$$

The resources allocated to school i are:

The resources allocated by the i school are:

$$R_i = \overline{x_n} - \overline{x_i} + x'_n \tag{17}$$

In this case, the amount R is greater than the actual demand, and all schools can be evenly allocated according to the average level of school educational resources.

To sum up, under the background of coordinated development of regional economy, the statistical index system of online education allocation resources is constructed, and the statistical index system is assigned. Based on the analysis of the balance of online education allocation resources, the statistical model of online education allocation resources is established to realize the statistics of online education allocation resources.

3 Comparative Analysis of Experiments

In order to verify the statistical performance differences between the online education allocation resource statistical model oriented to the coordinated development of regional economy, the statistical model of online education allocation resource in literature [3] and the statistical model of online education allocation resource [4] in literature [4] are designed.

Step 1: collect the data of online education allocation resources respectively in the statistical model of online education allocation resources;
Step 2: analyze the weight of online education allocation resource data in the statistical index system of online education allocation resources;
Step 3: a resource statistician for the coordinated development of regional economy, using online education allocation resource statistical model to clean online education allocation resource data;
Step 4: according to the above processing steps, extract the characteristics of online education allocation resource data;
Step 5: test the statistical efficiency of online education resource allocation data. The test results are shown in Fig. 1.

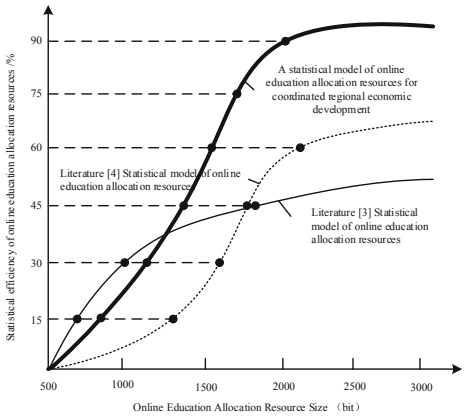

Fig. 1. Comparison results of statistical efficiency of online education allocation resources

As can be seen from the experimental results in Fig. 1, with the increase of online education allocation resources, the statistical efficiency of online education allocation resources is also increasing. The statistical efficiency of online education allocation resource statistical model oriented to the coordinated development of regional economy is far higher than the other two statistical models. Compared with the online education allocation resource statistical model in literature [3], online education allocation resource statistical efficiency in literature [4] is higher than that in literature [3] The statistical efficiency of setting up resource statistical model is relatively high. Because the statistical

model of online education allocation resources in literature [3] pays more attention to manual operation and lacks intelligence in the application process, literature [4] lacks the depth of students' demand in practical application, which leads to the reduction of the statistical efficiency of online education allocation resources and faces regional economic coordination The developed statistical model of online education allocation resources can fully meet the needs of students for online education allocation resources, thus improving the statistical efficiency.

On the basis of meeting the statistical efficiency of online education allocation resources, we also need to verify students' satisfaction with online education allocation resources. We conducted a satisfaction experiment on the statistical model of online education allocation resources. We investigated 200 users each time, and adopted the statistical model of online education allocation resources oriented to the coordinated development of regional economy and the literature [3] online education allocation resource statistical model [4] the statistical model of online education allocation resources is used to analyze students' satisfaction. The comparison results of online education allocation resource satisfaction are shown in Table 4.

Table 4. Comparison results of personalized learning satisfaction

Number of surveys	Student satisfaction%		
	Literature [3] personalized learning recommendation system based on statistical model of online education allocation resources	Literature [4] personalized learning recommendation system based on statistical model of online education allocation resources	Literature [5] personalized learning recommendation system based on statistical model of online education allocation resources
1	48.32	68.74	92.84
2	53.18	64.58	94.36
3	49.65	58.79	95.18
4	50.34	69.62	96.14
5	51.62	71.07	92.42
6	50.37	65.37	98.54
7	49.68	68.35	99.83
8	49.15	64.82	94.67
9	48.36	68.79	97.21
10	50.19	64.31	86.49

It can be concluded from the experimental results in Table 4 that the same survey was conducted on 200 students. Due to the lack of intelligent operation in literature [3], the satisfaction of students was greatly reduced. The satisfaction of students using the statistical model of online education allocation resources in literature [4] was basically

lower than 70%, and only one survey result was higher than 70%, which may be the result of this group of survey students on resources The demand of statistical model is low, and the student satisfaction of the statistical model of online education allocation resources oriented to the coordinated development of regional economy is generally higher than 90%, and even close to 100%. Therefore, we can get the statistical model of online education allocation resources for the coordinated development of regional economy, which can achieve the effect of students' satisfaction.

4 Conclusion

This paper puts forward a statistical model of online education allocation resources for the coordinated development of regional economy. Under the background of coordinated development of regional economy, the statistical index system of online education allocation resources is constructed, and the statistical index system is assigned. Based on the analysis of the equilibrium of online education allocation resources, the statistical model of online education allocation resources is established to realize online education allocation Statistics of resources. The experimental results show that the model has higher statistical ability.

However, due to the limited use of literature and the huge database of online education allocation resources, the design process of statistical model of online education allocation resources is not perfect and can not be widely applied to practice. In the future research, we need to further expand the scope of research and apply the statistical model of online education allocation resources to practice, Increase the feasibility of the model.

References

1. Liu, W., Maurer, H.P., Reif, J.C., et al.: Optimum design of family structure and allocation of resources in association mapping with lines from multiple crosses. Heredity **110**(1), 71–79 (2013)
2. Grüneberg, W.J., Abidin, E., Ndolo, P., et al.: Variance component estimations and allocation of resources for breeding sweetpotato under East African conditions. Plant Breeding **123**(4), 311–315 (2010)
3. Sun, L.: Driving mechanism of the coordinated development of regional economy-society-environment system based on grey incidence analysis model—a case study of Wanjiang urban belt. Mod. Econ. **11**(7), 1226–1244 (2020)
4. Panikkai, S., Azrai, M., Fahmi, F.N.: Model production of corn development for industrial needs and increasing economy. In: IOP Conference Series: Earth and Environmental Science, vol. 484, no. 1, p. 012137 (10) (2020)
5. Rejeb, H.B., Zwolinski, P.: Development of educational contents on circular economy and critical raw materials challenges. Procedia CIRP **90**(12), 759–765 (2020)
6. Sopilko, N.Y., Myasnikova, O.Y., Navrotskaia, N.A., et al.: Analysis and prospects for the development of regional energy integration of the Eurasian economic union countries. Int. J. Energy Econ. Policy **10**(5), 13–20 (2020)
7. Rubio, G., Lavado, R.S.: Acquisition and allocation of resources in two waterlogging-tolerant grasses. New Phytol. **143**(3), 539–546 (2010)
8. Fu, W., Liu, S., Srivastava, G.: Optimization of big data scheduling in social networks. Entropy **21**(9), 902 (2019)

9. Liu, S., Li, Z., Zhang, Y., et al.: Introduction of key problems in long-distance learning and training. Mob. Netw. Appl. **24**(1), 1–4 (2019)
10. Liu, S., Lu, M., Li, H., et al.: Prediction of gene expression patterns with generalized linear regression model. Front. Genet. **10**, 120 (2019)
11. Yan, X., Song, W., Liu, C.: Social-spatial accessibility to urban educational resources under the school district system: a case study of public primary schools in Nanjing, China. Sustainability **10**, 2305 (2018)
12. Creighton, J.H., Berger, C., Johnson, J.E.: Key issues affecting oregon family forest owners: a scoping review of the literature and survey analysis of educational service providers. Small-Scale Forestry 1–17 (2019)
13. Wang, S.: Research on the fairness index and an empirical study of the basic education resources allocation: the case of primary schools in Xicheng District, Beijing. Comput. Econ. Soc. Syst. **1**, 122–129 (2018)
14. Zhao, L., Wu, D., Wang, Z., et al.: Spatio-temporal pattern and influencing factors of the allocation of rural basic education resources in China. Econ. Geogr. **38**(11), 39–49 (2018)
15. Cai, W., Huang, J.: Imbalance and adaptation: spatial pattern evolution of higher education resource allocation in China. Heilongjiang Res. High. Educ. (5), 28–34 (2018)