The Construction of the Measurement Model of Balanced Development of Compulsory Education Resources based on the Hierarchical Analysis Method

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Abstract: - The balanced development of compulsory education is an important measure to fully implement the equalization of basic education public services, promote education equity, and maintain social justice. Among the paths to the realization of balanced development of compulsory education, the most crucial is to ensure the balanced development of compulsory education resources, so it should attract high attention. The purpose of this paper is to construct a measurement model of the balanced development of compulsory education resources, to explore the key factors affecting the balanced development of compulsory education resources, and to find a scientific path for the balanced development of compulsory education resources. Based on this, this paper uses the method of hierarchical analysis to construct a measurement model of the balanced development of compulsory education resources, analyzes the measurement model of the balanced development of compulsory education resources in a certain region, and concludes that the main factors include school conditions, teacher quality, and education funding. Accordingly, this paper further proposes effective strategies for the balanced development of compulsory education resources from the aspects of increasing education funding, refining the assessment indicators of relevant staff, improving the personnel system of teachers, implementing the mobility policy of teachers, and strengthening the construction of basic resources. The research of this paper, on the one hand, can provide a guarantee for the development of balanced compulsory education resources in a certain region, and on the other hand, it can also provide certain references for the solution of the problem of balanced development of compulsory education resources in other regions with similar situations, and it has strong practical significance for the effective realization of balanced development of compulsory education.

Key-Words: - Compulsory Education; Balanced Development; Resource Allocation; Financial Investment; Hierarchical Analysis; Educational Resources; School Conditions.

1 Introduction

The balanced development of compulsory education reflects the fairness of education, and one of the manifestations of educational fairness is the balanced allocation of educational resources, however, at present, the phenomenon of non-equalization of educational resources is more common in China, the balanced allocation of educational resources has become a hot issue of educational reform, [1]. The OECD education indicator system, which is very representative of the measurement of the level of equalization of compulsory education, has the functions of systematic decision-making, reflection of effectiveness, process monitoring, and comparability, and is of great significance to China in terms of both the theory and the content composition of its education indicators. In addition, [2], used enrollment data to estimate the Gini coefficient of education in 16 East African countries, which solved the problem of how to determine and where to allocate investment in education to reduce inequality between and within countries. There are more studies on the equalization of compulsory education in China, such as, [3], who used social surveys and GIS methods to take kindergartens, elementary schools, and junior high schools as the units of educational facility provision and proposed guiding standards for the allocation of basic public service facilities in villages, including the indicator of 1,000

school places, the appropriate radius of service and the minimum size. [4], constructed a system of indicators to measure the level of basic education resource allocation, including quality indicative, configuration guiding, and funding guarantee, used weighted indexes and models to calculate the level of education resource allocation in primary and junior high schools, and cluster analysis to classify the types of elementary school. [5], established the indicator system from three aspects of education opportunities, education process, and education results, and evaluated the level of equalization of basic education in China by using the coefficient of variation method and principal component analysis. However, overall the related research on the measurement model of regional equalization of compulsory education resources is relatively insufficient. Based on this, this paper established a more complete indicator system for the balanced development of urban and rural compulsory education and scientific measurement tools suitable for a particular region.

2 Analysis of the Allocation Status Quo of Compulsory Education Resources in a Certain City

2.1 Teacher Status has Improved, but the Difference between Urban and Rural Areas is Relatively Significant

Table 1. Rural and urban teacher status at various stages

		2016	2022
Teacher-Student Ratio	Urban Primary Schools	5.7%	6.0%
	Rural Elementary Schools	4.4%	5.9%
	Urban Junior High School	6.7%	7.0%
	Rural Junior High School	5.0%	7.0%
Middle and senior titles	Urban Elementary Schools	37.1%	47.3
	Rural Elementary School	34.84%	38.81%
	Urban Junior High School	37.16	54.16%
	Rural Junior High School	26.2%	44.42%
Upgrading of academic qualifications	Urban Elementary Schools	74.5%	95.13%
	Rural Elementary School	67.44%	86.76%
	Urban Junior High School	47.3%	89.88%
	Rural Junior High School	36.92%	76.7%

The data in Table 1 shows the basic situation of teachers in urban and rural areas at all stages, including the teacher-student ratio, senior and middle-level titles, and the advancement of academic levels. The specific analysis is shown below:

2.1.1 Differences in Student-Teacher Ratios
In terms of teacher-student ratios, the difference in teacher-student ratios in compulsory education is lower than the national average, but the difference is gradually narrowing. In general, the difference between urban and rural pupil/teacher ratios has decreased due to an increase in rural pupil/teacher ratios but little change in urban pupil/teacher ratios. However, this data also shows that the urban-rural gap is higher than the national average, indicating that there are still relatively large urban-rural differences in the region, [6]. The rural teacher-student ratio in elementary school has been on an upward trend for five consecutive years, rising from 0.044 in 2016 to 0.059 in 2022; the urban teacher-student ratio has been fluctuating, with an insignificant trend. The middle school rural student-teacher ratio has shown an upward trend for five consecutive years, from 0.05 in 2016 to 0.070 in 2022; the urban student-teacher ratio has shown fluctuating changes with insignificant trends.

2.1.2 Differences in Senior and Middle-Level Titles
On middle and senior titles, the urban-rural difference in the proportion of full-time teachers with middle and senior titles in compulsory education has gradually decreased, but the urban-rural difference is higher than the national one. The urban-rural difference in the proportion of full-time teachers with middle and senior titles gradually decreases, but the urban-rural difference is higher than the national level, [7]. The chemical example of the proportion of teachers with senior titles in rural and urban areas is on the rise, with elementary school rural areas rising from 34.84% in 2016 to 38.81% in 2022, and urban areas rising from 37.1% in 2016 to 47.3% in 2022; junior high school rural areas rising from 26.2% in 2016 to 44.42% in 2022, and urban areas from 31.76% in 2016 fluctuating up to 54.16% in 2022. The gradual decrease in the urban-rural difference is due to the relatively low percentage of rural middle and senior titles before 2016 and the faster growth in the percentage of rural full-time teachers with middle and senior titles after 2016. The proportion of urban and rural middle and senior titles is lower than that of the national urban and rural respectively, indicating that the urban-rural

difference is higher than that of the national mainly because the proportion of rural middle and senior titles is lower than that of the national rural middle and senior titles.

2.1.3 Differences in the Improvement of Teachers' Qualifications

As for the proportion of teachers with improved qualifications, the proportion of teachers with improved qualifications in compulsory education is higher than the national level, [8]. The difference in the proportion of full-time teachers with improved qualifications is gradually decreasing, and the difference is lower than the national level. Although the proportion of teachers with improved qualifications in both rural and urban areas has been increasing, from 67.44% in 2016 to 86.76% in 2022 in rural areas at the elementary school level, and from 74.50% in 2016 to 95.13% in 2022 in urban areas; at the junior middle school level, from 36.92% in 2016 to 76.70% in 2022 in rural areas, and from 47.3% in 2016 to 47.3% in 2022 in urban areas, the difference in the proportion of full-time teachers with improved qualifications is gradually decreasing, and the difference is lower than the national level of 47.3 percent to a chipped 89.88 percent in 2022.

2.2 School Conditions have Gradually Improved, but Urban-Rural Differences Still Exist

2.2.1 Differences in School Space per Pupil

By analyzing the indicator of average school floor space, the elementary school stage fluctuates and rises, and the urban-rural difference is higher than the national average; in the middle school stage, the urban-rural difference is gradually smaller than the national average. The faster growth rate of rural per capita school building areas is the main reason for the gradual reduction of the urban-rural difference. The faster growth rate of rural per capita school building space is mainly due to the fact that, on the one hand, the structural adjustment of the layout of rural primary and secondary schools requires the retention or establishment of new central schools, and the building or expansion of primary and secondary schools through the assistance of various national projects has greatly increased the supply of school buildings in the countryside, [9]. On the other hand, rural-urban migration is also a key factor, with large numbers of laborers migrating to the cities, their accompanying children are also moving to the urban schools in large numbers, resulting in a decrease in the number of rural school students year

by year and an increase in urban school students year by year.

2.2.2 Difference in the Number of Books per Pupil

In terms of the number of books per pupil, the level of urban-rural disparity in the number of books per pupil is higher than the national average at the elementary school level and decreases at the lower secondary school level, but is greater than the national average, [10]. The changes in the urban-rural difference in the number of books per pupil are due to the changes in the rate of increase in the number of books per pupil in rural and urban areas. The rural and urban per-pupil levels in elementary school are not yet standardized. The lower secondary school urban average will be standardized by 2021, while the rural average will not yet be standardized.

2.2.3 Differences in the Number of Computers per Student

Data on urban-rural differences in the number of computers per pupil show that they are lower than the national average at all stages and that the urban-rural differences are gradually narrowing, gradually falling below the national average.

2.3 Funding Inputs Continue to Grow, but Urban-Rural Differences are still Obvious

Table 2. Rural and urban funding by stage (ten thousand)

		2016	2021
financial investment	Urban Primary Schools	525.09	1778.76
	Rural Elementary Schools	444.62	1329.03
	Urban Junior High School	762.42	2357.65
	Rural Junior High School	611.57	1702.41

Table 2 illustrates the status of rural and urban funding at various stages, according to the data in the table, the urban-rural ratio of budgeted public expenditure per pupil shows a fluctuating downward trend. Although rural and urban areas show an overall upward trend in budgeted public expenditure per pupil, elementary school rural areas increased from 444.62 in 2016 to 1,329.03 in 2021, and urban areas increased from 525.09 in 2016 to 1,778.76 in 2021; junior high school rural areas increased from 611.57 in 2016 to 1,702.41 in 2021, and urban areas

increased from 762.42 in 2016 to 2,357.65 in 2021. This shows that since the reform of coordinating urban and rural areas, the budgeted education expenditure in both urban and rural areas has increased greatly, but because of the large size of Chongqing's rural areas and the large rural population, the budgeted public expenditure per student in rural areas is still lower than that in urban areas, and the urban-rural difference in the budgeted public expenditure per student has gradually increased and is larger than the national average, [11]. This suggests that funding for rural areas should be emphasized as a means of narrowing the gap between urban and rural areas.

3 Establishment of a Model for Measuring and Evaluating the Balanced Development of Compulsory Education Resources in a City

3.1 Determination of Indicators of Balanced Development of Compulsory Education Resources

The top 20 main factors affecting the balanced development of compulsory education in the region were counted in the form of questionnaires according to the combined number of importance levels of the indicators, [12]. The 12 indicators whose combined importance ratings were higher than the average were selected. Compulsory education resource allocation is divided into three first-level indicators: schooling conditions, teacher quality, and education funding. The conditions for running schools include two indicators: campus layout and hardware facilities; teacher quality includes two indicators: teacher structure and exchange training; and education funding includes two indicators: funding input and funding utilization. The construction of the overall indicators is shown in Table 3.

Table 3. Compulsory education resource allocation indicator system

Level 1 indicators	Level 2 indicators	Level 3 indicators
A School conditions	A1 Campus Layout	A11 Compliance rate of sports ground
		A12 Multimedia classrooms per student
	A2 Hardware Facilities	A21 Campus network completion rate
		A22 Average number of computers per student
B Quality of Teachers	B1 Teacher Structure	B11 Percentage of middle and senior teachers
		B12 Percentage of teachers with higher qualifications than required
	B2 Exchange and Training	B21 Number of professional training attended by teachers per year
		B22 Number of annual exchanges between urban and rural teachers
C Funding for education	C1 Funding Input	C11 Budgeted utility expenses per pupil
		C12 Budgeted utility expenses per pupil
	C2 Utilization of Funds	C21 Funding for teachers' continuing education
		C22 New education expenditure per student

3.2 Construction of Compulsory Education Resource Balance Development Measurement Model

3.2.1 Model Construction and Calculations

Because the data of the indicator factors reacting to the balanced level of compulsory education resources have a discrete type, and the education problem is complex and changeable, and affected by subjective and objective factors, the calculation method of the weight of the indicators chooses the Delphi method in the subjective assignment method, [13].

Questionnaire Designed Based on the Fields Method "Questionnaire for Determining the Weights of the Evaluation Indicators of Urban and Rural Compulsory Education Resource Allocation in a Certain Region" was distributed to 25 experts and scholars in the field of this study. Each indicator was rated from 1 to 5 as "strongly disagree", "disagree",

"generally agree", "agree" and "strongly agree". The "level of agreement" was assigned a value of "1, 2, 3, 4, 5". Ignore the effect of "strongly disagree" and "disagree" on the level of agreement of the indicator. The weights of "generally agree", "agree", and "strongly agree" are as follows:

$$X = \frac{\alpha_i}{\alpha_1 + \alpha_2 + \alpha_3} \quad (i = 1,2,3) \qquad (1)$$

Where α_i is the weighted value of the three degrees, and the weights are calculated to be 25%, 33%, and 42% in order. A total of 25 questionnaires were recovered, and the data of the questionnaires were counted and organized to measure the degree of agreement of each three-level indicator, which was announced as follows:

$$Y = \beta_1 \times 25\% + \beta_2 \times 33\% + \beta_3 \times 42\% \quad (i = 1,2,3) \ (2)$$

Where $\beta_i, i = 1,2,3$ is the statistical frequency of the degree of agreement. 12 three-level indicators of the degree of agreement are calculated, and the weight of each three-level indicator is

$$Z_i = \frac{Y_i}{\sum_{k=1}^{12} Y_k} \quad (i = 1,2,...,12) \qquad (3)$$

After two rounds of Delphi method calculation adjustment, experts' opinions converge in the third round. The data in Table 4 illustrate the evaluation indicators and their weights for the allocation of resources to compulsory education.

From the above results, it can be seen that the expression is as follows

$$Y = 28.94\%A + 31.55\%B + 39.5\%C \qquad (4)$$

Where A is the first-level indicator of schooling conditions, B is the first-level indicator of teacher quality, and C is the first-level indicator of education expenditure.

Table 4. Evaluation indicators of compulsory education resource allocation and their weights

Level 1 indicators	Level 2 indicators	Level 3 indicators	Weights(%)
A School conditions(28.94)	A1 Campus Layout	A11 Compliance rate of sports ground	7.05
		A12 Multimedia classrooms per student	7.16
	A2 Hardware Facilities	A21 Campus network completion rate	6.98
		A22 Average number of computers per student	7.75
B Quality of Teachers(31.55)	B1 Teacher Structure	B11 Percentage of middle and senior teachers	8.75
		B12 Percentage of teachers with higher qualifications than required	8.16
	B2 Exchange and Training	B21 Number of professional training attended by teachers per year	7.23
		B22 Number of annual exchanges between urban and rural teachers	7.41
C Funding for education(39.5)	C1 Funding Input	C11 Budgeted utility expenses per pupil	9.68
		C12 Budgeted utility expenses per pupil	10.44
	C2 Utilization of Funds	C21 Funding for teachers' continuing education	10.18
		C22 New education expenditure per student	9.2

3.2.2 Analysis and Discussion of Results

Based on the construction of the previous model and the calculations, the impact indicator with the highest percentage is education funding, with 39.5%. It is followed by teacher quality, which occupies 31.55%, and school conditions, which occupies 28.94%. Among them, among the education expenditure, the per capita budgeted utility expenditure occupies 10.44%, followed by teachers' continuing education expenditure, which shows that teachers' strength is an important factor affecting the equalization of compulsory education resources. As for the quality of teachers, the introduction of highly educated teachers and exchange and training are the contents that need to be paid attention to, especially the factors of teachers' academic qualification improvement and title promotion, which occupy 8.16% and 8.75% respectively. In terms of school conditions, attention should be paid to the construction of teaching equipment, computers, and other infrastructures, to lay a good foundation for the balanced development of compulsory education resources.

4 The Allocation Optimization Path of Balanced Development of Compulsory Education Resources

4.1 Support Economically Weak Areas, Increase the Investment in Compulsory Education Funding

Compulsory education adopts a "county-based" management system, due to differences in fiscal revenues between district (city and county) level governments, resulting in gaps in education funding between districts (cities and counties), [14]. The level of economic development has an impact on the distribution of regional funding for education, so the fundamental solution to implementing and improving the allocation of resources for compulsory education is to support economically weak regions. Based on guaranteeing economic development, we must implement a favorable policy for education funding in weak regions.

4.2 Strengthening the Building of the Teaching Force to Ensure the Equalization of Compulsory Education Resources

The building of the teaching force plays an important role in the balanced development of compulsory education resources. An excellent principal and a group of outstanding teachers can raise the overall standard of school operation and teaching. The key to narrowing the gap between urban and rural compulsory education and strengthening the construction of compulsory education schools lies in improving the overall quality of the principal and teacher teams. Firstly, increase the number of annual exchanges between principals and teachers in urban and rural areas, so that excellent urban primary and secondary school principals can go to primary and secondary schools in townships and have exchanges with principals of primary and secondary schools in townships, and excellent urban primary and secondary school teachers can go to primary and secondary schools in townships and have exchanges with primary and secondary school teachers in townships and teach them experience, to promote the development of the primary and secondary school teachers' team in townships. Secondly, the training of primary and secondary school teachers in townships should be strengthened, and the forms of training can be varied, such as allowing primary and secondary school teachers in townships to go to primary and secondary schools in cities with a higher level of schooling for further study, organizing primary and secondary school teachers in townships to participate in professional development training at or above the municipal level in the summer and winter vacations, and organizing exchanges of study between urban and rural primary and secondary school teachers with backbone, and so on. Finally, to encourage township primary and middle school teachers to improve their qualifications while ensuring that the treatment of township primary and middle school teachers is not lowered, a form of semi-professionalization can be adopted to eliminate the worries of township primary and middle school teachers who are interested in improving their qualifications but are afraid of a reduction in their treatment. At the same time, for primary and secondary school teachers in townships, appropriate policy preferences should be given for the promotion of higher-level titles and the evaluation of prizes and merits.

4.3 Improve the Teacher Personnel System and Increase the Human Resources of Compulsory Education

Teachers' personnel system directly affects teachers' stability and motivation. And the current tension in teachers' establishment is related to the imperfection of the teachers' personnel system. Based on this, schools should deal with the problem of seconded staff establishment, so that the teachers' establishment will not be occupied or wasted, thus

allowing more excellent and capable fresh blood to join the teaching force and increasing the human resources of compulsory education, therefore, improving the teachers' personnel system is also one of the effective strategies.

4.4 Implementing Teacher Mobility Policy and Establishing an Effective Guarantee Mechanism

To equalize teacher resources among schools, an exchange approach can be adopted. Every teacher who has served in the same school for six years can apply for mobility to other schools, and school principals are required to rotate on average every few years. The mobility of teachers (including front-line teachers and administrative staff) in compulsory education should tend to be normalized and standardized. The implementation of a teacher mobility policy for all urban districts is also an important way to promote a balanced allocation of teacher resources among districts (cities and counties).

4.5 Strengthening the Construction of Physical Resources and Guaranteeing Physical Resources for Compulsory Education

Physical resources mainly include school buildings, teaching instruments and equipment, books, and so on, which is the result of education expenditure. The reasonable allocation of physical resources meets the demand for compulsory education resources of educated this, at the same time guarantees the balanced development of compulsory education. Enhancement of the hardware equipment of schools in different parts of the region in accordance with their level of education and related requirements, and for areas with weak financial resources, the district (city or county) level government may give certain inclinations in terms of policy, so that all districts (cities or counties) are equipped with standardized schooling conditions.

5 Conclusion

The balanced development of compulsory education in urban and rural areas is an important factor for educational equity, and there are more conditions affecting it, accompanied by the preliminary establishment of the measurement model of balanced development of compulsory education resources, which can provide corresponding evaluation tools for the evaluation of balanced development of regional compulsory education.

According to the data of the measurement model, it can be seen that the important indicators affected are mainly school conditions, teacher quality, and education funding.

Although the research in this paper has achieved certain results, there are still some limitations in the research results due to the relatively limited scope of the survey and the relatively small sample data. Therefore, in future research, we will apply a wide range of analytical methods to expand the scope of the study and the sample data to obtain more detailed data information, so that the research results can be applied to a wider range of regions.

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The authors equally contributed to the present research, at all stages from the formulation of the problem to the final findings and solution.

Conflict of Interest
The authors have no conflicts of interest to declare.