Research Article

Balanced Allocation of Educational Resources Based on Parallel Genetic Algorithm

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Higher education is one of the scarcest social resources, with high demand and low supply, and higher education is currently in limited supply in our country, making it difficult to resolve this contradiction. In addition to increasing investment in higher education as much as possible, the most important thing is to maximize the benefits of education through the rational allocation of resources. An evaluation index system of educational resource input-output was constructed, and a multiobjective function model of educational resource utilization efficiency and allocation efficiency was proposed. We should rationalize the allocation of resources and maximize the benefits of innovation and entrepreneurship education in colleges and universities. By combining particle swarm optimization with genetic algorithm, we can simulate and solve the model. The simulation results suggest that by optimizing the usage and allocation efficiency of innovation, it may be increased. College and university entrepreneurship education resources have increased by 18.72 percent and 20.98 percent, respectively, on average, and tend to be in a balanced state, which can realize the optimization of education resources allocation.

1. Introduction

Social progress is inseparable from the development of education. Achieving the all-round development of higher education and the rational allocation of higher education resources can optimize the funds of higher education institutions, including equipment, teachers, and administrators. Higher education resources refer to excellent educational talents, strong material, and financial resources in the education process [1]. Rich educational resources can distinguish the running ability of a school and judge its teaching quality. Therefore, the rational allocation of educational resources is an important socialized project. In order to realize fairness and justice in the social distribution of higher education resources, we should pay more attention to educational efficiency and strive to realize the popularization of higher education [2]. The majority of teaching techniques in Chinese colleges and universities are still lecture-oriented, which causes students to be unable to think for themselves, hindering the development of students’ personalities and making it hard to tap students’ potential and increase learning motivation. In addition, the teaching system also directly affects students’ learning. Due to the limited educational resources, current classroom teaching activities need to be carried out according to the nature of educational resources, which also affects the expansion and distribution of educational resources.

Higher education resource is an important social resource, which is based on the level of economic development. The proportion of higher education investment in the gross national economy and the proportion of financial expenditure can only fluctuate within a certain range and cannot be too large or too small. Investment in higher education is not for profit, but to meet the needs of economic and social development. Therefore, the optimization goal of higher education resource allocation is consistent with the goal of social and economic development. The optimal allocation of educational resources is an important factor affecting the high-quality development of higher education,
realizing educational equity, and improving the connotation of higher education. In order to promote an innovation-driven development strategy and relieve employment pressure, although China attaches great importance to innovation and entrepreneurship education in colleges and universities, and the total amount of educational resources invested increases year by year, there are still problems such as insufficient investment, uneven allocation, and low utilization efficiency of resources [3]. As a result, people from all walks of life are concerned about how to rationalize resource allocation and maximize the benefits of schools and institutions, and there should be a focus on entrepreneurialism.

Higher education is a quasipublic good with strong positive externalities. When a person receives education, he or she can benefit not only himself or herself, but also other members of society. This positive external effect of higher education reflects that the social production cost of education is less than the private production cost, or the total external effect of the society is greater than the external effect of a single member of the society. In this case, calculating the best option is tough for higher education resource allocation to obtain all personal preferences. From the perspectives of policy change [4], influencing factors [5, 6], “double first-class” construction [7], regional economy [8], and technical support [9], domestic researchers have carried out theoretical and empirical studies on the connotation, characteristics, influencing factors, and existing problems of optimal allocation of educational resources and put forward corresponding suggestions for optimizing resource allocation. Through the in-depth analysis of the existing research results, it is found that there is less research on the allocation of educational resources, and the research objects are mostly universities directly under the Ministry of education. “Double first-class” universities have high scientific research capabilities, and there is little research on ordinary local universities and universities in a province. In terms of research dimension, it is mainly a single dimension such as production efficiency and loss efficiency of allocation efficiency, and few of them are combined. In terms of research methods, we mainly use data envelopment analysis [10] and the linear programming method for constructing the CCR-BCC model, and the evolutionary algorithm using the genetic algorithm (GA) is studied, but the PSO algorithm is seldom studied.

In view of the problems existing in the above research, this paper intends to build an evaluation index system of educational resources input and output and proposes a multiobjective function model to improve the utilization efficiency and allocation efficiency of educational resources and obtain the optimal scheme of resource allocation by combining PSO algorithm and genetic algorithm. The optimal distribution of innovation and entrepreneurship education resources in universities is the subject of this research in Shanxi province as the research object and realizes the optimization of educational resources allocation by simulating each resource allocation to complete the calculation and search for the optimal allocation.

The research is organized as follows: the educational resource allocation optimization and algorithm design are presented in Section 2. Section 3 analyzes the experiment and result. Finally, in Section 4, the research work is concluded.

2. Educational Resource Allocation Optimization and Algorithm Design

In this section, we define the construction of an educational resource evaluation index system, multiobjective optimization analysis, model construction, PSO algorithm, and genetic algorithm in detail.

2.1. Construction of Educational Resource Evaluation Index System. “Educational efficiency” is one of the indicators to measure educational achievements. [11] The academic efficiency of how to rationally distribute the limited institutions and universities’ capabilities to gain the optimum educational output with the smallest unit input is central to the optimal allocation of educational resources for universities, and there is a focus on entrepreneurship. The links between inputs and outcomes are difficult to quantify and analyze since the educational system is a complex system with various inputs and outputs. Therefore, establishing the resource index system and multi-objective optimization mathematical model of entrepreneurship and innovation education is of great significance to improve the efficiency of entrepreneurship and innovation education and optimize the allocation of resources.

In order to build the input-output index system of educational resources, we choose the indicators of innovation and entrepreneurship education and resource input-output and build the innovation and entrepreneurship education resources into an output index system around the two issues of “university entrepreneurship education support table” and “whether the evaluation index system can support innovation and entrepreneurship education,” as shown in Table 1.

The output index system of innovation and entrepreneurship education resources in colleges and universities is divided into six input-output indicators, secondary indicators of educational resources, secondary indicators of human resources and secondary indicators of material resources, and 12 three-level indicators such as the number of managers and teachers. To provide a theoretical framework, the index system for the building of a multiobjective optimization model is constructed.

2.2. Multiobjective Optimization Analysis and Model Construction. The following two objectives are presented to maximize the deployment of innovation and entrepreneurship school resources in colleges and universities.

(1) Improve the efficiency with which entrepreneurship education resources are used. That is, to maximize educational output by organizing limited resources.
(2) Improve the efficiency with which resources for entrepreneurial education initiatives are allocated. In other words, to maximize the proportion of educational resources in each input resource, the complexity and particularity of each resource and its impact on educational results should also be considered, so that each resource can be effectively allocated to the most suitable aspect.

Multiple factors influence the distribution of innovation and entrepreneurship education resources in colleges and universities, and their allocation is not straightforward or linear. The ultimate goal is to maximize the educational results; that is, the utilization efficiency of resources for entrepreneurship and innovation learning is the ratio of educational output and educational input, and its expression is

$$U = \frac{\sum_{j=1}^{m} \mu_j O_j}{\sum_{i=1}^{n} \phi_i I_i}$$  \hspace{1cm} (1)

where $i$ and $j$ represent educational resource elements and educational outcome elements, respectively; $O_j$ and $I_i$ are output and input of educational resources, respectively; $\phi_i$ and $\mu_j$ are the weight of educational resource input index and output index, respectively. The higher value is, the higher the input-output ratio is, the higher the utilization efficiency of educational resources is, and the more reasonable the combination of educational production factors is, and vice versa.

According to the input-output index system of college and university resources for entrepreneurship education, the ratio of teachers to students, the number of administrative teachers per student, the number of teachers with enterprise backgrounds, the value of teaching instruments and equipment per student, and the use of practice platform per student were constructed successively. Seven indicators of innovation and entrepreneurship education resource allocation efficiency include room area, per-student education base area, and per-student special fund. The expression of the objective function of the $i^{th}$ innovation and entrepreneurship education resource allocation in the $k^{th}$ university is

$$A_{ki} = \frac{X_k + \Delta X_k}{S_k} \hspace{1cm} (k = 1, 2, \ldots, K),$$

subject to

$$0 \leq A_{ki} \leq 1 \hspace{1cm} (i = 2, 3),$$

$$A_{ki} > 1 \hspace{1cm} (i = 5, 6, 7),$$

where $S_k$ is the number of students in the $k^{th}$ university; $X_k$ and $\Delta X_k$ are the average value and variation of each resource element of innovation and entrepreneurship in the $k^{th}$ university. Comprehensively considering the objective function of (1) and (2), the multiobjective optimization function of innovation and entrepreneurship resource allocation is

$$\max U_k = \frac{\sum_{j=1}^{m} \mu_j O_j}{\sum_{i=1}^{n} \phi_i I_i},$$

$$\max F_k = \sum_{i=1}^{n} \phi_i A_{ki}, \hspace{1cm} k = 1, 2, \ldots, k,$$

where $\max U_k$ is the maximum educational resource utilization efficiency of universities and colleges; $\max F_k$ aims to maximize the allocation efficiency of educational resources in colleges and universities.

### 2.3. PSO Algorithm

PSO algorithm [12] is another new swarm intelligence algorithm after the ant colony algorithm and also a meta-heuristic optimization algorithm based on bionics. It has the characteristics of strong robustness, fast convergence, simple and easy code and is easy to implement in programming. With the need for research problems and the improvement of methods, a multiobjective particle swarm optimization (MOPSO) algorithm for solving complex multiobjective optimization problems is proposed, and its expression is

$$V = w V_i + c_1 r_1 (y_i - P_i) + c_2 r_2 (g_i - P_i),$$

$$P_{r+1} = P_i + V_{r+1},$$

where $\mathbf{P}_i$ is the best solution found in the past, $\mathbf{g}_i$ is the best solution of all solutions, and $\mathbf{y}_i$ is the current particle position.
where \( P_i \) and \( V_i \) represent the current position vector and velocity of the particle, respectively. \( y_i \) and \( g_i \), respectively, represent the individual optimum of particles and the global optimum of all particles. \( w \) is the weighting coefficient. \( r()_1 \) and \( r()_2 \) are random numbers between \([0–1]\); \( c_1 \) and \( c_2 \) represent acceleration factors, respectively. In the optimization process, particles update their own state according to their own velocity inertia, their own optimal position, and group optimal position.

### 2.4. Genetic Algorithm

A genetic algorithm (GA) is a search method that mimics nature’s evolution process in order to find the best solution. The algorithm process can be expressed as follows: first, take the solution of the model as chromosome coding, then select and set the population size of the initial population, determine the fitness function of each chromosome according to the objective function, successively use replication operator, crossover operator and mutation operator to carry out population, and constantly iterate and evolve. The fitness value of the method remains unchanged or terminates the algorithm before reaching the expected number of iterations for many times [13]. The chromosomes are decoded, and the results are given.

The Pareto multiobjective genetic algorithm can sketch in large-scale complex genetic algorithm random search, and each generation can interact with the benefits of a set of solutions, but unlike single-objective optimization genetic algorithms, multiobjective algorithms must guide the genetic direction, preserve population diversity, and minimize optimal solution loss, among other things, to improve. The fitness assignment technique must be set properly in order to lead the evolution in the right direction. The layer-by-layer classification approach is used here [14], which means that the level of all noninferior individuals in the current population is set to 1 to remove them from the population momentarily. The level of all noninferior individuals in the remaining population was set to 2, and they were likewise temporarily eliminated, and so on until all individuals were ranked. Finally, the decision vector space-based sharing function approach is used to assign virtual fitness values to each participant depending on their grade.

The best person retention method can prevent excellent individuals from being lost due to random factors throughout the optimization process [15]. The procedure entails combining the parent and child populations into a new population, ranking it, and calculating the virtual fitness of each person. The population was sorted into two parts: better and worse, based on the level of noninferior solution and the size of virtual fitness, and the greater part was chosen to be passed down to the next generation. The algorithm flow chart is shown in Figure 1.

The diversity approach adopted by MOGA and NSGA is called fitness sharing. The fitness sharing method first calculates the distance between different individuals using the following formula:

\[
d(I_1, I_2) = \sqrt{\sum_{k=1}^{K} \left( \frac{f_k(I_1) - f_k(I_2)}{f_k^{\max} - f_k^{\min}} \right)^2},
\]  

where \( f_k^{\max} \) represents the maximum \( k \) target value found so far, similarly \( f_k^{\min} \). For individual 1, we can calculate its niche count.

\[
nc(I) = \max_{X, \text{fitness}(X)=\text{fitness}(I)} \left( \frac{\sigma_{\text{sharing}} - d(I, X)}{\sigma_{\text{sharing}}}, 0 \right).
\]  

Then, the individual’s niche count is used to adjust the individual’s fitness.

\[
\text{fitness}(I)' = \frac{\text{fitness}(I)}{nc(I)}.
\]  

Nsga-i takes a different approach, called the crowding distance, and we perform the following operations:

\[
cd_k(I[i,k]) = \frac{f_k(I[i-1,k]) - f_k(I[i+1,k])}{f_k^{\max} - f_k^{\min}}.
\]

After calculating the distance to get to an individual, we do not use it to adjust the fitness but use a different selection method. We pick two individuals at random. If the fitness of the two is different, the individual with the higher fitness is selected. If the fitness is the same, individuals with large crowding distances will be selected. The following figure is the schematic diagram of fitness sharing and crowding distance (the left figure represents fitness sharing, and the right figure represents crowding distance). The fitness sharing and crowding distance schematic diagram are shown in Figure 2.

A multiobjective evolutionary algorithm is a global optimization search algorithm based on an evolutionary mechanism, which can effectively solve complex multi-objective optimization problems. By adopting the Pareto optimization concept, a multiobjective genetic algorithm can approach the Pareto frontier through the evolution of generations of populations, thus overcoming the limitation of traditional methods in solving multiobjective problems.

### 3. Experiment and Results

#### 3.1. The Data Source

Taking six colleges and universities and six other ordinary local colleges and universities in Shaanxi province that have won the "top 50 typical colleges and universities with national innovation and entrepreneurship experience” as the research samples, our data are derived from the 2017-2019 innovation and entrepreneurship education resource statistical database (China Education Statistical Yearbook) and relevant statistical data.

Since educational resources have different dimensions and dimension units, we have quantified and standardized the input-output index data of college educational resources from 2017 to 2019, so as to avoid the dimensional impact between indicators. At the now, colleges and universities in Shaanxi are primarily concerned with the issues outlined below when it comes to the distribution of resources for entrepreneurship education. To begin with, educational resources have a low utilization efficiency. For example, universities C7, C2, and C9 have higher resource input superposition values of 4.08, 4.10, and 4.15, respectively, but
the superposition value of educational output is not significantly different from other universities. Secondly, there are great differences in resource allocation between and within colleges and universities. For example, in terms of faculty allocation, the ratio of college C6, full-time and part-time teachers, administrative teachers, and off-campus teachers with enterprise backgrounds is 1:0.80:0.70.23, it can be seen that C8 has a small number of full-time teachers and teachers with enterprise backgrounds in innovation and entrepreneurship teachers, and there is a significant difference in resource input between universities. Finally, there are also great differences in the allocation of resources within colleges and universities. For example, the ratio of the number of teachers per student, the investment of special funds per student, and the area of practice base per student is 1:2:59412 and 1:0.7:18097, respectively. It can be seen that there is no clear standard in resource allocation among colleges and universities, and there are great differences in resource allocation.

3.2. Simulation Parameter Setting. When we combine the innovation of entrepreneurship education in academic institutions with the multi-purpose function of resources, we can regard it as a particle, each particle is a configuration scheme, and we can get the individual optimal
solution y. When each particle is the optimal configuration scheme, the population optimal solution G can be obtained. Therefore, when all particles are the most optimal, the optimal global solution G can be obtained through iteration, so as to output the global optimal configuration scheme. The multiobjective optimization objective function and constraint conditions of innovation and entrepreneurship resource allocation are integrated, and the simulation operation is carried out on the simulation software. The iteration diagram of the algorithm is shown in Figure 3.

As can be seen from Figure 3, when the number of iterations reaches about 400, it tends to be stable, and the fitness function tends to the minimum value. At this time, the five optimal solutions we can get show that when the allocation proportion of various resources in colleges and universities is high, the utilization and allocation efficiency of educational resources is the highest, and the ability of innovation and entrepreneurship is strong.

In order to verify whether the model improves the resource allocation efficiency, the original data of colleges and universities and the optimized allocation scheme (optimal solution 1) are substituted into formula (4) to calculate the overall college and university resource allocation effectiveness before and after optimization, as shown in Table 2.

As can be seen from Table 2, the interschool resource allocation efficiency varies greatly before the experiment, with the minimum value being 0.123 and the maximum value being 0.187. After optimization, the allocation efficiency is 0.189, with an average increase of 20.89%, indicating that the optimization of educational resource allocation can be realized by adjusting the quantity and structure of educational resources. Taking the teacher/student ratio of a single index as an example, t is calculated according to formula (2) to calculate the resource allocation efficiency of the teacher/student ratio of each university before and after optimization, and the data are normalized, as shown in Figure 4.

It can be seen from Figure 4 that before the experiment, the efficiency interval of faculty-student ratio resource allocation in each university is large, indicating that there is a large difference in resource allocation between and within universities, and there is no clear standard. After optimization, the teacher staffing level is 0.72, reaching a reasonable ratio and standard.

<table>
<thead>
<tr>
<th>University</th>
<th>Resource allocation efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before the trial</td>
<td>After the optimization</td>
</tr>
<tr>
<td>C1</td>
<td>0.127</td>
</tr>
<tr>
<td>C2</td>
<td>0.184</td>
</tr>
<tr>
<td>C3</td>
<td>0.131</td>
</tr>
<tr>
<td>C4</td>
<td>0.174</td>
</tr>
<tr>
<td>C5</td>
<td>0.183</td>
</tr>
<tr>
<td>C6</td>
<td>0.161</td>
</tr>
<tr>
<td>C7</td>
<td>0.185</td>
</tr>
<tr>
<td>C8</td>
<td>0.145</td>
</tr>
<tr>
<td>C9</td>
<td>0.173</td>
</tr>
<tr>
<td>C10</td>
<td>0.187</td>
</tr>
<tr>
<td>C11</td>
<td>0.123</td>
</tr>
<tr>
<td>C12</td>
<td>0.153</td>
</tr>
</tbody>
</table>

Figure 3: The iteration diagram of the algorithm.

Table 2: Resource allocation efficiency of colleges and universities before and after the experiment.
4. Conclusion

The new development path of higher education reforms is innovation and entrepreneurial education, which is linked to talent cultivation and higher education standards. The optimum amount of innovation and entrepreneurship educational materials in colleges and universities is linked to not only the development of colleges and universities and the farming of regional skills and abilities but also the advancement of national higher education’s overall level and scientific use of national higher education resources.

According to simulation results, the utilization efficiency of innovation and entrepreneurship education resources in colleges and universities is low before improvement, with high input and low production, low input, and low yield. The allocation of resources varies greatly between and within universities, and there is no clear standard. After optimization, the resource utilization efficiency of universities increased from 0.695∼1.010 to 1.026∼1.084, with an average increase of 18.72%, and tended to the equilibrium state, and the adjustment of the number and structure of educational resources realized the optimization of educational resource allocation. At the same time, it also verifies the necessity of allocating and optimizing the existing resources of innovation and entrepreneurship education in colleges and universities and the effectiveness of the model and algorithm, but it only stays at the level of experimental simulation, and the practical effect needs further empirical research.

5. Discussion

The high-quality development of higher education focuses on enhancing the effectiveness and quality of educational resources input and output. How to effectively improve the utilization efficiency and allocation efficiency of educational resources at the level of colleges and universities is proposed as follows.

To begin, the study is expanded into the most efficient utilization of university resources for innovation and entrepreneurship. A science-based understanding of the current state of allocation of resources in colleges and universities is helpful for increasing the utilization efficiency and capital allocation of educational resources, thereby reducing problems such as low resource allocation rate with high input and low output, high input and low output, and low input and low output. Finding out what factors influence the best use of educational resources in colleges and universities is beneficial, as is proposing focused strategies to improve the efficiency and quality of educational resources in colleges and universities.

Second, the educational resource management mode is innovated, and a scientific-educational resource input-output system is established. Universities on the basis of enhancing investment in education information should establish the scientific education resources system, establish a scientific management system, and introduce advanced resource management technologies to promote the output conversion of the resources, impel the technology introduction of resource management system innovation impetus, and improve the efficiency of education resource utilization and configuration.

Finally, based on reality, full play is given to their own competitiveness, and the output of educational resources is improved. For example, research-oriented universities can improve their educational output by actively participating in various innovation and entrepreneurship competitions and project incubation activities at all levels.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that they have no conflicts of interest.

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