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Research Ability of Academic Postgraduates Based on the Method of Optimum Index of Target Analysis Evaluation Research

Rongli Guo[1,*], Haoyan Wang[1]

[1]*Harbin University of Commerce, Harbin, 150028, China*
[*]*Corresponding author*

Abstract: *The cultivation of the scientific research ability of postgraduates is the key factor to judge the quality of training on postgraduates in China, and the core element to promote the cultivation of high-quality talents and the development of high-tech in China. Therefore, by means of questionnaire survey, factor analysis and target analysis, the paper is committed to constructing the evaluation system of the scientific research ability of postgraduates and establishing the weight of index to make the scientific evaluation of their ability in scientific research. It aims to help teaching and research workers in university, management authorities and individuals establish a more scientific and reasonable model of postgraduate training.*

Keywords: *Postgraduates, Scientific research ability, Evaluation system, Method of Optimum Index of Target Analysis*

1. Introduction

In the 21st century, with the rapid prosperity of politics, economy, society and culture and the acceleration of globalization, faced up with the increasingly fierce international competition, the social demand for scientific research talents is increasing day by day, and there is an unprecedented development trend of talent training in China. It is particularly emphasized in the *Twelfth Five-Year Plan* issued by China in March 2011: "Highlighting the cultivation of students' scientific spirit", which not only puts forward a clear development direction for the cultivation of high-quality scientific research talents in China, but also puts forward higher requirements for the cultivation of the scientific research ability of talents in colleges and universities. In 2004, Article 5 of the *Regulations of the People's Republic of China on Academic Degrees* clearly stipulated the conditions for granting graduate degrees. One of the conditions is: They shall have the ability to undertake scientific research or carry out technical activities alone. It emphasizes the necessity for postgraduates to have the scientific research ability from the perspective of policy [1]. In the *21st Century Action Plan for Invigorating Education*, the Ministry of Education also points out to promote the plan for "high-level creative talent project", and clearly puts forward that scientific research talents are essential in building a harmonious society. Under such circumstance, as the source of talent cultivation, colleges and universities have deeply realized the significance of strengthening the cultivation of scientific research ability of postgraduates. Postgraduates are the reserve force for national development in the future, the scientific evaluation of their scientific research ability is the guiding light for the direction of talent training in colleges and universities and the favorable guarantee for the improvement of national strength in scientific research. Therefore, how to effectively evaluate the scientific research ability of postgraduates and how to establish the scientific evaluation index system of scientific research ability has become a hot spot in the current academic circles.

The research of experts and scholars at home and abroad on issues related to the scientific research ability of postgraduates can be divided into the following categories according to their different research angles.

1.1. On the connotation of scientific research ability of postgraduates

At present, the connotation of "scientific research ability" has not been uniformly defined in the academic circles, which is diversely understood by scholars. For example, Lu Wei points out in his paper that although there are many explanations for scientific research ability in academic circles, it has

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not been uniformly defined, and each definition has only been recognized within a certain category [2]; Guoying Bian believes that the scientific research ability refers to the ability to obtain innovative achievements through research in new fields; Jin Wang defines the scientific research ability as the ability to discover, analyze, solve problems and innovate in analyzing problems [3]; Yunwei Zhou believes that the scientific research ability of postgraduates is the most basic ability that postgraduates should have. It is a series of psychological qualities and abilities generated in the process of seeking new knowledge and solving new problems by using their own knowledge and scientific methods; Li Duan points out in her paper that the scientific research ability of postgraduates is a collection of abilities that should be possessed in the whole process of scientific research. To sum up, this paper holds that the scientific research ability of postgraduates refers to various abilities that should be possessed by postgraduates to apply scientific methods to pursue the truth of things [4].

1.2. From the perspective of structural elements of the scientific research ability of postgraduates

Wanjin Meng (2001) divides the scientific research ability into five categories according to the importance of the ability required by postgraduates, which are as follows: Ability in innovation, ability in flexible thinking, ability in data collection and processing, ability in problem-solving and ability in communication [5]. In the *Exploration of New Model for the Cultivation of the Scientific Research Ability of* Postgraduates *of Physical Education*, Tao Jiang and Kaimei Chen (2007) point out that scientific research ability includes basic quality and innovation ability, and basic quality includes literature reading ability and thesis topic selection ability; Innovation ability includes independent scientific research ability, paper publishing ability, practical ability, extracurricular work design ability, etc. In the *Research on the Scientific Research Ability of Full-time Liberal Arts Postgraduates in Colleges and Universities*, Ruirui Zhao points out that the structural elements of the scientific research ability of postgraduates are as follows: Ability in language expression, ability in data collection and processing, ability in flexible thinking, ability in social practice, etc. In the paper of *Research on the Training Quality Evaluation System of Postgraduates of Physical Education*, Ruilin Zhang (2010) emphasizes that on the one hand, the scientific research ability includes ability in knowledge understanding, logic ability, practical ability, and on the other hand, it includes rigorous scientific research attitude and proficiency in scientific methods [6].

1.3. From the perspective of evaluation of the scientific research ability of postgraduates

Lingling Xu (1997) combines analytic hierarchy process with TOPSIS method to create the method of optimum index of target analysis for the evaluation of the scientific research ability of postgraduates in the *Comprehensive Evaluation of Preliminary Scientific Research Ability of Postgraduates by Means of Optimum Index of Target Analysis*; In the *Evaluation Index System of Preliminary Scientific Research Ability of* Undergraduates, Weimo Huang and Lihua Cao (2002) construct a set of evaluation system of the scientific research ability of undergraduates by the combination of the expert consultation method and principal component analysis method, and set the weight again by the expert consultation method or expert ranking method. However, due to the subjectivity, the evaluation system needs to be tested in terms of science; In *Research for Doctor's Scientific Research* Ability *Evaluation Index System and Evaluation Method*, Caixia Wang (2006) establishes the evaluation system of the scientific research ability of postgraduates from the three dimensions of learning ability, scientific research innovation ability and practice ability of scientific research [7]; In Research *and Implementation of Evaluation System of Scientific Research Innovation Ability of Postgraduates of Science and Engineering*, Ying Yan and Bohong Liu (2009) establish a set of evaluation system of the scientific research ability of postgraduates from the perspectives of degree thesis, scientific research project, academic exchange and teaching materials; In the paper of Discussion on the Evaluation System of Scientific Research Ability of College Students in Newly Built Local Colleges and Universities, Yanhong Xie (2010) adopts the analytic hierarchy process to establish the evaluation system of scientific research ability of college students through three dimensions: basic ability, practice ability of scientific research and scientific research innovation ability [8].

1.4. Literature review

Although academic experts have conducted research on the evaluation of scientific research ability of postgraduates from different perspectives, it still needs to be deeply discussed in the following aspects: First, although the scientific research ability of postgraduates has been defined through numerous studies, there is still no connotation of the same authority; Second, numerous scholars focus

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on the structural elements and training mode of scientific research ability of postgraduates, and less on the evaluation of scientific research ability of postgraduates. The index system is lack of science and integrity; third, although there are many discussions on one aspect of the cultivation of the scientific research ability of postgraduates, there are few holistic studies on the cultivation of the scientific research ability of postgraduates. It can be seen through the above analysis that it still needs to be further discussed to construct the reasonable evaluation system of the scientific research ability of postgraduates and set the effective the training program of postgraduates on the basis of reference to the evaluation results.

2. Construction of the evaluation system of the scientific research ability of postgraduates

2.1. Principles for the construction of the evaluation index system

Constructing the scientific evaluation system of the scientific research ability of postgraduates can effectively promote the cultivation of the scientific research ability of postgraduates. However, we should consider not only the limitations of the ability level of postgraduates, but also the stimulation of scientific research interest of postgraduates in terms of construction of the evaluation system of the scientific research ability of postgraduates. Therefore, several basic principles should be followed for the establishment of the index system.

2.1.1. Guidance principle

Make sure that the constructed indicators have a continuous guiding role for the evaluation object. The objective of the index system is not only to evaluate the level and ranking of the scientific research ability of postgraduates, but also to guide the cultivation of postgraduates in colleges and universities to meet the needs of social and economic development.

2.1.2. System principle

It is necessary to set up many indicators for evaluation for the design of the index system. Those indicators complement each other and the difference between indicators at the same level is maximized without overlapping to ensure that it is systematic. It is necessary to make sure that each evaluation index is defined with a scientific and reasonable connotation, and the calculation method is scientific and accurate during index screening and weight calculation.

2.1.3. Operational principle

Make sure that the established indicators are simple, reasonable and repeatable. As for the evaluation index, it is necessary to consider not only the simplicity and rapidity of operation, but also the authenticity and accessibility of data to ensure that the evaluation results can withstand repeated tests. Unnecessary indicators shall be deleted on the premise that the evaluation results are accurate and scientific to avoid the intersection of indicators.

2.2. Establishment of evaluation index system

Based on references 4, 5, 6 and 7, the paper summarizes 35 level-III indicators. It determines 23 level-III indicators on the basis of expert interviews and questionnaire surveys, and finally pre-drafts the evaluation indicators of the scientific research ability of postgraduates, as shown in Table 1.

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Table 1: Pre-drafted indicators for evaluation of the scientific research ability of postgraduates

Level I indicator	Level II indicator	Level III indicator
Basic scientific research ability	Professional foundation	V1 Reserve of professional knowledge
		V2 Application degree of professional knowledge
	Learning ability	V3 Literature review ability
		V4 Ability in information collection and processing
	Attitude on scientific research	V5 Rigorous attitude
		V6 Careful thinking
Practice ability of scientific research	Find problems	V7 Keen ability to explore problems
		V8 Insight into the future
		V9 Ability of subject selection
	Analyze problems	V10 Thinking ability
		V11 Analysis and demonstration ability
	Solve problems	V12 Practical ability
		V13 Independent decision-making ability
		V14 Organization and coordination ability
Scientific research and innovation ability	Paper published	V15 Number of papers published
		V16 Number of citations
		V17 Journal level of the paper
	Dissertation	V18 Perspective of the topic selection of the paper
		V19 Innovation of theory and method
		V20 Significance of results and benefits
	Scientific research project	V21 Level of project
		V22 Contribution of participation in project
		V23 Scientific research achievement and award

2.3. Selection and revision of evaluation indexes for the scientific research ability of postgraduates

2.3.1. Sample selection and sample

Table 2: Statistics of basic information of respondents

Item	Type	Number of people	Percentage of people %
Gender	Male	198	57.9
	Female	144	42.1
Discipline nature	Social science	132	38.6
	Natural science	210	61.4
Age	Under 25 years old	0	0
	26-35 years old	72	21.1
	31-45 years old	125	36.5
	Over 45 years old	145	42.4
Education	Tutor of postgraduates	138	40.4
	Researcher	121	35.4
	Postgraduate	83	24.2
Length of service	1-5 years	31	9.0
	6-10 years	85	24.9
	11-20 years	123	36.0
	More than 21 years	103	30.1

The paper adopts questionnaires and expert interviews as the main research methods. After the preliminary design of the questionnaire was completed in March 2015, 20 teachers from Harbin Engineering University and Harbin University of Commerce were selected as the subjects for a small-scale survey. Among them, there were 3 teachers majoring in management science and engineering, 2 teachers majoring in applied economics, 5 teachers majoring in business administration, 7 teachers majoring in public management and 3 teachers majoring in finance, including 6 professors (30%), 10 associate professors (50%) and 4 lecturers (20%). Finally, the questionnaire was revised according to the completion of the questionnaire and the suggestions given by the teachers, and finally formulated. Then, questionnaires were sent to Harbin Engineering University, Harbin Institute of Technology, Harbin University of Commerce, Liaoning University and other universities by e-mail,

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mail and on-site investigation. There were 21 items in the survey, 342 questionnaires were sent, and 301 were recovered, with the recovery rate of 88%. Among them, 21 questionnaires were invalid and eliminated. Finally, there were 280 questionnaires, and the overall validity of the questionnaire was 93%. The specific conditions of the samples are shown in Table 2.

2.3.2. Reliability test of evaluation index scale

Reliability refers to the stability and the heterogeneity of the test results. The greater the reliability is, the smaller the test standard error is. The questionnaire is in the form of attitude, so Cronbach αis selected to test the reliability. Cronbach α greater than 0.8 indicates that the reliability of the questionnaire is acceptable; Cronbach α between 0.7 and 0.8 indicates that there are some deficiencies in the questionnaire and it needs to be corrected; Cronbach α below 0.7 indicates that the questionnaire has great defects and needs to be re- established. Through the reliability test, the reliability values of the scale in the three constructs of basic scientific research ability, practice ability of scientific research and scientific research innovation ability are 0.843, 0.801 and 0.867 respectively, which are higher than 0.800. It is qualified through the reliability test. See Table 3 for details.

Table 3: Reliability test results of the scale

Scale name	Cronbach's Alpha	Reliability level	N of items
Foundation of scientific research	0.843	Accepted	4
Scientific research practice	0.801	Accepted	8
Scientific research innovation	0.867	Accepted	9

2.3.3. Validity test of evaluation index scale

Validity refers to the accuracy of detection tools and means on the test object, that is, effectiveness. The paper adopts factor analysis, which is one of the commonly used methods to test the validity of the questionnaire. KMO is used to test the validity of the scale. Factor analysis can be carried out only when the value is greater than 0.6 and the probability of significance is less than 0.01. Through the validity test of the questionnaire, KMO values of basic scientific research ability, practice ability of scientific research and scientific research innovation ability are 0.762, 0.814 and 0.798 respectively, and the probability of significance is 0.000, 0.000 and 0.000, less than 0.01, which is in line with the significance level, indicating that factor analysis can be carried out on the questionnaire, as shown in Table 4.

Table 4: KMO and Bartlett's test

Scale name	Sampling adequacy KMO	Probability of significance
Foundation of scientific research	0.762	0.000
Scientific research practice	0.814	0.000
Scientific research innovation	0.798	0.000

SPSS21.0 software is used to select 23 items in the scale into the implementation of factor analysis to obtain the component matrix. There are 9 common factors in the table. However, the original 4th construct is divided into two constructs in the matrix, and item 9 is considered to be deleted because it is the largest factor load; Then, 22 items excluding item 9 are selected into the implementation of factor analysis to obtain the composition matrix table 5 after the rotation axis. The structure of common factors and sub factors in the framework is just consistent with the three evaluation criteria of scientific research innovation ability, practice ability of scientific research and basic scientific research ability originally conceived, and conforms to the prepared framework.

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Table 5: Summary of factor analysis results

		Component								
		Professional foundation	Learning ability	Attitude on scientific research	Ability in finding problems	Ability in analyzing problems	Ability in solving problems	Paper published	Dissertation	Scientific research project
Professional foundation	Reserve of professional knowledge	.694								
	Application degree of professional knowledge	.796								
Learning ability	Literature review ability		.549							
	information collection and processing		.801							
Attitude on scientific research	Rigorous attitude			.769						
	Careful thinking			.844						
Find problems	Keen ability to explore problems				.806					
	Insight into the future				.813					
Analyze problems	Thinking ability					.808				
	Analysis and demonstration ability					.709				
Solving problems	Practical ability						.843			
	Independent decision-making ability						.826			
	Organization and coordination ability						.796			
Paper published	Number of papers published							.731		
	Number of citations							.845		
	Journal level of the paper							.731		
Dissertation	Perspective of the topic selection of the paper								.843	
	Innovation of theory and method								.753	
	Significance of results and benefits								.791	
Scientific research project	Level of project									.620
	Contribution of participation in project									.496
	Scientific research achievement and award									.704

3. Introduction of method of optimum index of target analysis

Method of optimum index of target analysis is a multi-target decision-making method established by combining the ideas of analytic hierarchy process and Topsis method [9]. The method is divided into four steps, namely target hierarchical screening, indicator weight setting, relative proximity of indicators and comprehensive index comparison [10]. Simple, intuitive and accurate, the method has great popularization value.

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3.1. Target hierarchical screening

First of all, the "evaluation of the scientific research ability of postgraduates" is determined as the general target. Secondly, the target tree is refined according to sub-targets under the general target to construct sub-targets. Finally, the sub-targets are refined, and the lowest level is the specific index of evaluation of the scientific research ability. The model is the structure of target tree, as shown in Figure 1.

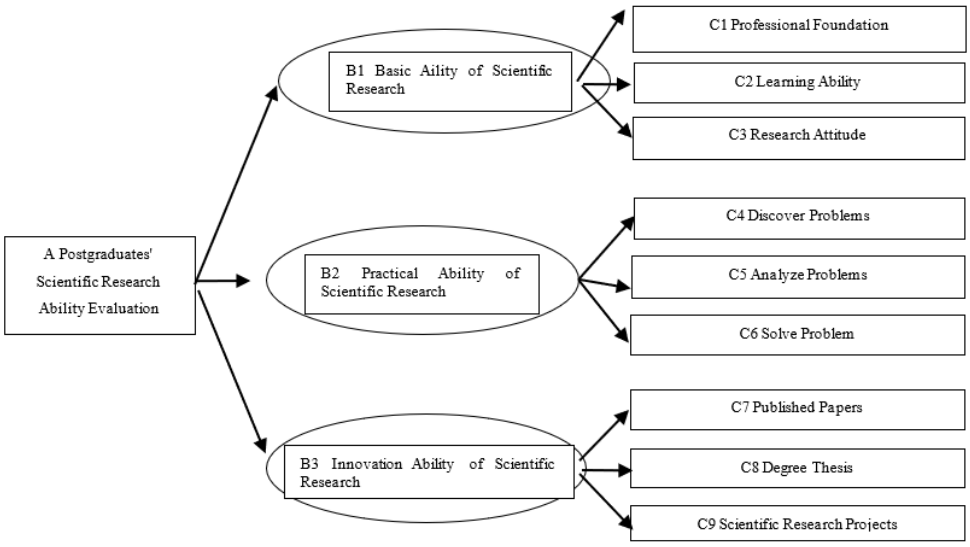

Figure 1: Structure of target tree of scientific research evaluation system for postgraduates

3.2. Calculation of index weight

3.2.1. Construction of judgment matrix

With the construction of the structure of target tree, the hierarchical relationship between the targets at each level is established. [10] Assuming that the lower level elements of the target element B are C1, C2, ... CN, it is to compare the influence of C1, C2, ... CN on the upper level element B, compare n elements in pairs, and represent the ratio of the influence of Ci and Cj on B by aij (with the determination basis of aij shown in Table 6). All the comparison results form the judgment matrix A.

$$A=\begin{bmatrix} a11 & a12 & ... & a1n \\ a21 & a22 & ... & a2n \\ ... & ... & ... & ... \\ an1 & an2 & ... & ann \end{bmatrix}$$

Table 6: Meaning of judgment matrix and scale

a_{ij}	Degree of difference between C_i and C_j
1	It indicates that C_i and C_j are of the same importance
5/4	It indicates that C_i is slightly more important than C_j
6/4	It indicates that C_i is significantly more important than C_j
7/4	It indicates that C_i is really more important than C_j
8/4	It indicates that C_i is absolutely more important than C_j

3.2.2. Determination of weight vector

Rank the importance of n elements C_1, C_2,... C_n to the superior target B, expressed by the weight vector W. The weight vector W is calculated by standardization of the corresponding eigenvector Wmax of maximum eigenvalue λmax of judgment matrix A.

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$$W=\begin{Bmatrix} w1 \\ w2 \\ \dots \\ wn \end{Bmatrix}$$

3.2.3. Consistency test

In consideration of the variability of thinking during the construction of the judgment matrix, it should be subject to consistency test. The test steps are as follows:

(1) Calculate the consistency index Ci. Assumingλ_{max} is the maximum eigenvalue of the judgment matrix A obtained by comparison of n elements in pairs, then: CI=. $\frac{\lambda \max - n}{n-1}$

(2) Calculate the consistency ratio CR. Assuming that RI is the averagely random consistency index value, it changes with the change of order of matrix A, as shown in Table 7. Then CR= CI/RI

Table 7: Values of multi-order judgment matrix ri

Orders	1	2	3	4	5	6	7	8
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41

If CR < 0.1, it indicates that the judgment matrix A has satisfactory consistency, and its corresponding weight vector W is the importance ranking of C_1, C_2,... C_n to the superior target B. On the contrary, it is necessary to modify the judgment matrix A.

3.3. Comparison of relative proximity of indicators

3.3.1. Collect initial data

Assuming there are n postgraduates and m evaluation indexes, the evaluation score of each postgraduates is expressed in the form of matrix X.

$$X=\begin{bmatrix} X11 & X12 & \dots & X1m \\ X21 & X22 & \dots & X2m \\ \dots & \dots & \dots & \dots \\ Xn1 & Xn2 & \dots & Xnm \end{bmatrix}$$

3.3.2. Determination of the optimal index value

m optimal index values are represented by vector Y, Y = (X_1, X_2, …X_m).

Among them, the maximum positive index is preferred, that is, $X_j=\max(X_{1j}, X_{2j}, \dots X_{nj})$,(j =1, 2, …m)

The minimum reverse index is preferred, that is, $X_j xj=\min(X_{1j}, X_{2j}, \dots X_{nj})$(j =1, 2, …m)

3.3.3. Normalization of the index data

The difference between the actual value and the optimal value of each postgraduate in the same index is compared by normalization of the index data. The normalization expression of the positive index is $Z_{ij}=X_{ij}/X_j$; The normalization expression of the inverse index is $Z_{ij}= X_j / X_{ij}$ (i=1, 2, …n;j=1, 2, …m; X_j is the optimal index value, Zij is normalized index value) to obtain the normalized matrix Z, which represents the relative proximity between the actual value and the optimal value. [11] The closer the relative proximity is to 1, the better the index level of the evaluated object is, the greater the weight share is, otherwise it is the opposite.

$$Z=\begin{bmatrix} Z11 & Z12 & \dots & Z1m \\ Z21 & Z22 & \dots & Z2m \\ \dots & \dots & \dots & \dots \\ Zn1 & Zn2 & \dots & Znm \end{bmatrix}$$

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3.4. Comparison of comprehensive index

3.4.1. Combined weight

Based on the principle of probability multiplication, the combined weight can be obtained by successively multiplying the weights of each layer with satisfactory consistency from bottom to top. It means the proportion of indicators in the overall objective evaluation, that is, the total ranking weight.

3.4.2. Comprehensive index

The comprehensive index of each postgraduate is obtained by multiplying the corresponding normalized index value by the combined weight. Through the comparison of the comprehensive index of postgraduates, their scientific research ability can be ranked. The larger the comprehensive index is, the closer it is to the optimal level, and vice versa.

4. Evaluation of the scientific research ability of postgraduates

Evaluation of the scientific research ability of postgraduates is mainly calculated in two aspects by the method of optimum index of target analysis. First, it is to determine the weight of each index according to the analytic hierarchy process, and then set the combination weight by the principle of probability multiplication. Second, it is to summarize the data from the lowest index of the structure of target tree according to the optimal index, and then multiply and accumulate it with the combined weight to obtain the comprehensive index, which can objectively evaluate the scientific research ability of postgraduates.

4.1. Construct the structure of target tree

Construct the structure of target tree of evaluation of scientific research ability of postgraduates, as shown in Figure 1 above

4.2. Calculation of index weight

Calculate the weight of each sub target of layer B:

Layer B in Figure 1 contains three sub targets B1 ~ B3. The judgment matrix A is obtained through comparison.

$$A=\begin{bmatrix} \frac{4}{7} & \frac{4}{5} & 1 \\ \frac{4}{6} & 1 & \frac{5}{4} \\ \frac{4}{7} & \frac{4}{5} & 1 \end{bmatrix}$$

The weight vector is obtained by approximate method.

W'1===0.770. $\sqrt[m]{\prod_{j=1}^{m} a1j}$ $\sqrt[3]{\left(\frac{4}{7}*\frac{4}{5}*1\right)}$ Similarly: W'2=0.941; W'3=1.380

Since =W'$_1$+W'$_2$+W'$_3$=3.091, $\sum_{i=1}^{m} w'i$

W_1= W'$_1$/3.091=0.2491; W_2= W'$_2$/3.091=0.3044; W_3=W'$_3$ /3.091=0.4465

The weight vector W =. $\begin{Bmatrix} 0.2491 \\ 0.3044 \\ 0.4465 \end{Bmatrix}$ The weight vectors of layer C and layer D are determined by the same method, as shown in Table 8.

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Table 8: Combined weight of each index

Weight of layer B	Weight of layer C	Weight of layer D		Combined weight of indicators
B1 0.2491	C1 0.37	D1	0.47	0.0433
		D2	0.53	0.0488
	C2 0.42	D3	0.24	0.0251
		D4	0.76	0.0795
	C3 0.19	D5	0.49	0.0231
		D6	0.51	0.0241
B2 0.3044	C3 0.38	D7	0.59	0.0682
		D8	0.41	0.0474
	C4 0.28	D9	0.38	0.0324
		D10	0.62	0.0528
	C5 0.34	D11	0.47	0.0486
		D12	0.31	0.0322
		D13	0.21	0.0227
B3 0.4465	C6 0.36	D14	0.26	0.0418
		D15	0.31	0.0498
		D16	0.43	0.0691
	C7 0.46	D17	0.27	0.0555
		D18	0.52	0.1068
		D19	0.21	0.0431
	C8 0.18	D20	0.20	0.0161
		D21	0.46	0.0370
		D22	0.34	0.0273

4.3. Consistency test

First, it is to obtain the maximum eigenvalue λmax of judgment matrix A.

λ_1===3.002

$$\frac{\sum_{j=1}^{n} a1j * wj}{w1} \quad \frac{1*0.4465+\frac{6}{4}*0.3044+\frac{7}{4}*0.2491}{0.4465}$$

In the same way, λ_2=3.001, λ_3=2.999

So, λ_{max}===3.001 $\frac{\sum_{i=1}^{n}\lambda i}{n}$ $\frac{\lambda 1+\lambda 2+\lambda 3}{3}$

Therefore, CI===0.0005; $\frac{\lambda \max - n}{n-1}$ $\frac{3.001-3}{2}$; CR=CI/RI=$\frac{0.0005}{0.58}$=0.0009<0.1

It indicates that the judgment matrix has satisfactory consistency. The weight vector W can be used as the importance ranking of the three sub targets of layer B to the overall target. Similarly, the consistency test is carried out on layer C and layer D to conclude that the matrix has satisfactory consistency.

4.4. Comprehensive evaluation

Limited by space, the scientific research ability of only 3 postgraduates selected is evaluated, and a number of experts give anonymous marks on 20 indicators of each postgraduate (the hundred-mark system is implemented). The comprehensive index of each graduate is calculated according to the obtained data, and the scientific research ability is objectively evaluated. See Table 9 and Table 10 for specific results.

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Table 9: Initial data and normalized data

Indicators	Combined Weight	Initial data			Optimal Indicators	Normalized data		
		1	2	3		1	2	3
D1	0.0622	93	92	95	95	0.9789	0.9684	1.0000
D2	0.0698	94	97	94	97	0.9690	1.0000	0.9690
D3	0.0227	86	91	92	92	0.9348	0.9891	1.0000
D4	0.0729	97	93	95	97	1.0000	0.9588	0.9794
D5	0.0104	87	92	87	92	0.9457	1.0000	0.9457
D6	0.0121	89	94	91	94	0.9468	1.0000	0.9681
D7	0.0682	82	84	87	87	0.9425	0.9655	1.0000
D8	0.0474	83	81	86	86	0.9651	0.9419	1.0000
D9	0.0324	90	81	92	92	0.9783	0.8804	1.0000
D10	0.0528	81	97	85	97	0.8351	1.0000	0.8763
D11	0.0486	96	92	93	96	1.0000	0.9583	0.9688
D12	0.0322	91	89	93	93	0.9785	0.9570	1.0000
D13	0.0227	85	92	86	92	0.9239	1.0000	0.9348
D14	0.0418	90	90	90	90	1.0000	1.0000	1.0000
D15	0.0691	90	98	92	98	0.9184	1.0000	0.9388
D16	0.0555	94	93	90	94	1.0000	0.9894	0.9574
D17	0.1068	89	95	88	95	0.9368	1.0000	0.9263
D18	0.0431	96	96	93	96	1.0000	1.0000	0.9688
D19	0.0161	85	93	90	93	0.9140	1.0000	0.9677
D20	0.0370	86	88	97	97	0.8866	0.9072	1.0000
D21	0.0287	94	92	91	94	1.0000	0.9787	0.9681
D22	0.0273	83	91	93	93	0.8925	0.9785	1.0000

Table 10: Comprehensive index

No.	1	2	3
Comprehensive Index	0.9355	0.9851	0.8417
Ordering	2	1	3

The comprehensive index of the first postgraduate is calculated as: 0.0622*0.9789+0.0698*0.9690+…+0.0273*0.8925=0.9355.

Similarly, the comprehensive index of the second postgraduate is 0.9851 and that of the third is 0.8417

4.5. Analysis of evaluation results

This paper analyzes the evaluation results of the scientific research ability of postgraduates through the combination of quantitative and qualitative analysis. In terms of quantitative analysis, it analyzes the results through standard scores, and standardizes the evaluation scores to form the hierarchical interpretation from high to low. According to the evaluation score, it is divided into: Excellent (100-85 points), good (84-70 points), qualified (69-60 points) and unqualified (below 59 points). In terms of qualitative analysis, it explains and analyzes the evaluation results by means of language description, which is convenient to find the actual situation and problems of the evaluation object [11]. The specific analysis is as follows.

According to the ranking results of the comprehensive index, the second postgraduate ranks first, the third postgraduate ranks second, and the first postgraduate ranks third. According to the analysis of the reasons, the second postgraduate generally has high scores, and the normalized data tends to 1. He maintains some certain advantages, so he ranks first. The first postgraduate generally has low scores, and the normalized data deviates from 1 compared with that of the first postgraduate. He has little advantage, so he ranks last.

In short, this paper aims to explore the establishment of the evaluation system of the scientific research ability of postgraduates. However, due to the limitation of research time and ability, coupled with other subjective and objective reasons, the results of the study only provide a thinking framework for the construction of the evaluation system of the scientific research ability of postgraduates, hoping to provide a reference for improving the cultivation of the scientific research ability of postgraduates in

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China. According to the observation and data sorting in the following years, it is found that the evaluation system has a more accurate prediction for the subsequent development level of scientific research for postgraduates.

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References

[1] Bing Wu, Lin Yongqiang. Research on the cultivation methods of the scientific research ability of postgraduates [J]. Journal of Henan Institute of Education (Natural Science Edition), 2010 (1): 68-69
[2] Na Wu. Research on the evaluation system of scientific research ability of postgraduates of physical education in Henan Province [D]. Henan: Henan University, 2013
[3] Bangrong Yang. On the scientific research ability of young teachers and training [J]. Journal of Xi'an Politics Institute, 2013 (6): 112-116
[4] Yinghua Ji. Research on evaluation index of scientific research innovation ability of postgraduates based on scientific research platform [J]. China Electric Power Education, 2013 (22): 26-28
[5] Caixia Wang. Research on evaluation index system and evaluation method of scientific research ability of students with doctor degree and master degree [D]. Xi'an: Southwest Jiaotong University, 2006
[6] Ruilin Zhang. Research on the evaluation system of training quality of postgraduates of physical education [J]. Journal of Shanghai Physical Education Institute, 2010 (4): 25-28,33
[7] Weimo Huang, Lihua Cao. Evaluation index system of preliminary scientific research ability of college students [J]. Technology, talent and market, 2002 (2): 22-25
[8] Yanhong Xie. Cultivation of elements of scientific research ability of undergraduates in local colleges and universities [J]. Journal of binzhou University, 2010 (4): 115-118
[9] Lingling Xu. Method of optimum index of target analysis for comprehensive evaluation of primary scientific research ability of postgraduates [J]. Academic Degrees & Graduate Education, 1997 (6): 44-47
[10] Xiaomin Gao, Penghua Wang, Shenghui Ma. Operational capability evaluation of artillery battalion based on analytic hierarchy process [J]. Shipboard Electronic Countermeasure, 2010 (3): 117- 119
[11] Ronghua Ding, Danli Bai, Bo Cheng. Research on comprehensive evaluation of college students from the aspect of comprehensive quality [J]. Bulletin of Science and Technology, 2001 (6) 30-34