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Research on the Optimization of a College Student Employment Competency Assessment Model Based on the Analytic Hierarchy Process

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Abstract Under the current background of massification of higher education, the contradiction between the continuous growth of the number of graduates and the relative scarcity of jobs is becoming more and more prominent, and the employers' requirements for the quality of talents are constantly improving. In order to scientifically assess the level of college students' employment ability and formulate effective promotion strategies, this paper constructs a comprehensive assessment model of college students' employment ability based on the combination of hierarchical analysis and fuzzy comprehensive evaluation. Methodologically, an evaluation index system containing 2 dimensions of external core competence and internal core competence, 5 first-level indexes and 18 second-level indexes is established, AHP is used to determine the weights of the indexes, and FCE is used for parameter adjustment and comprehensive evaluation. By empirically analyzing the questionnaire data of 537 college students, the results show that: the composite score of the dimension of extrinsic core competence is 2.530, and the composite score of the dimension of intrinsic core competence is 2.599, both of which are in the range between the poor and the average level; the degree of mastery of professional knowledge is relatively better, with a score of 3.28; students of different majors differ significantly in all the competence dimensions, and the nature of the colleges and universities shows a significant difference in the 13 competence dimensions showed significant differences. The conclusion shows that the overall level of the current college students' employment ability is low, and it is necessary to comprehensively improve the employment ability by changing the concept of employment, strengthening the practical exercise, optimizing the education mode, and deepening the cooperation between schools and enterprises.

Index Terms Employability of college students, Hierarchical analysis method, Fuzzy comprehensive evaluation, Indicator system, Empirical analysis, School-enterprise cooperation

I. Introduction

The comprehensive evaluation model of college students' employability is an important tool for evaluating and improving the comprehensive quality of college students [1]. Hierarchical analysis method (AHP) is a quantitative analysis method used to solve multi-criteria decision-making problems, which can be used to construct a comprehensive evaluation model of college students' employment ability and effectively assess the ability level of college students [2]-[4]. The employment ability of college students involves many aspects, such as professional knowledge ability, communication and expression ability, innovation ability and so on [5]. When constructing the evaluation model of college students' employment ability, the evaluation factors are first determined and divided into levels. The evaluation factors can be divided into first-level indicators and second-level indicators [6], [7]. First-level indicators are the main components of college students' employability, such as professional knowledge ability, teaching ability, communication and expression ability [8]. The secondary indicators are the specific quantitative indicators after the refinement of the first-level indicators, such as the research level of the specialized knowledge field, oral expression ability, etc [9]. Secondly, the weight calculation and consistency test are carried out using the AHP method, and a judgment matrix needs to be constructed for the first-level and second-level indicators, which reflects the relative importance between different indicators [10], [11]. The judgment matrix can be derived by comparing the first-level and second-level indicators two by two.

Next, the weights are calculated by the AHP method, which first calculates the weight of each first-level indicator, then calculates the weight of each second-level indicator, and conducts the consistency test to ensure the reliability of the evaluation model [12]-[14]. Finally, the evaluation model was established. By quantifying the specific abilities of teacher training students, the evaluation model of college students' employment ability can be constructed [15].

This model can be used to statistically and evaluate the ability level of college students and compare it with the employment market demand [16]. By analyzing the evaluation results, it can provide personalized directions and suggestions for college students to improve their abilities and help them better adapt to the job market [17], [18].

This study adopts a combination of quantitative and qualitative research methods, firstly, it constructs the evaluation index system of college students' employment ability through literature combing and expert interviews, and divides the employment ability into two dimensions: extrinsic core ability and intrinsic core ability. Secondly, the hierarchical analysis method is used to determine the weights of indicators at all levels, and the consistency test ensures the scientificity of the judgment matrix. Then, the assessment parameters are adjusted by combining the fuzzy comprehensive evaluation method to construct a complete assessment model. Finally, empirical data are collected through a large-scale questionnaire survey, and the constructed model is used to conduct a comprehensive assessment of college students' employability, and analyze the differential characteristics among different groups, on the basis of which targeted strategies for improving employability are proposed.

II. Construction of a comprehensive assessment model for college students' employability

II. A. Evaluation indicators

On the basis of collecting a large amount of literature on college students' employability, comparing and analyzing the composition of existing college students' employability, determining the necessary elements for college students' high-quality employment, and forming a college students' employability index system from two different focuses, namely, college students' extrinsic core ability and intrinsic core proportion. The indicator system of college students' employment ability in different dimensions is shown in Table 1, including 2 dimensions, 5 first-level indicators and 18 second-level indicators.

First, external core ability. This indicator mainly takes into account various observable competencies. In order to further clarify the extrinsic core competence, it is divided into professional knowledge and understanding ability and practical skills. Professional knowledge and understanding ability reflects the mastery of college students' professional subject knowledge and their ability to understand knowledge and information. Practical skills reflect the various types of skills needed in practical work, emphasizing the application of subject knowledge at the practical level.

Second, intrinsic core competence. This indicator mainly examines the implicit ability of college students, which is relative to the extrinsic core ability, i.e., this ability is more difficult to observe, but is the basis for the formation of extrinsic core ability. Self-efficacy and metacognition are both elements of intrinsic core competence. On this basis, the content of job adaptation and development is also included, reflecting the high-quality employment characteristics of college students.

Table 1: The employment ability index system of college students in different dimensions

Dimension	Primary indicator	Secondary indicator
External core capacity	Professional knowledge and understanding X1	Professional knowledge X01
		Understanding of knowledge and information X02
	Practical skill X2	Team ability X03
		Communication ability X04
		Complex problem handling ability X05
		Logical reasoning ability X06
		Executive ability X07
Inner core capacity	Self-efficacy X3	Self-confidence X08
		Self-management X09
		Self-awareness/self-reflection ability X10
		Self-motivation X11
		Empathy X12
	Metacognition X4	Innovative ability X13
		Learning ability X14
	Job adaptation and development X5	Career planning ability X15
		Social ability X16
		Adapt to work and environmental ability X17
		Resistance to frustration/pressure resistance X18

II. B.AHP model construction and parameter adjustment

In this paper, the hierarchical analysis method is first used to analyze the weights of the evaluation indexes of college students' employability, and then combined with the fuzzy comprehensive evaluation method to evaluate the strengths and weaknesses of the second-level indexes under each dimension in college students' employability, and to determine the adjustment parameters of college students' employability.

II. B. 1) Determining indicator weights based on AHP

Determining the weights of indicators for evaluating the employability of university students is an important basis for influencing the accuracy of their evaluation. The weights of the evaluation indicators of employability determine the degree of influence of each evaluation indicator on the employability of college students. When determining the weights between the evaluation indicators, the scientific nature of the comprehensive analysis of the indicators will be lost if the qualitative analysis of each evaluation indicator is carried out independently, therefore, the consistent matrix method is used to establish the correlation between the evaluation indicators.

By comparing the importance of each evaluation indicator to X_i, a comparison matrix A can be established. For example, the importance of the i th evaluation indicator to X_i is U_i, and the importance of the j th evaluation indicator to X_i is U_j, then $U_i : U_j = a_{ij}$. $A = (a_{ij})_n X_n, a_{ij} > 0$ and $a_{ji} = 1 / a_{ij}$. Then:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \tag{1}$$

If $a_{ij} * a_{jk} = a_{ik}$ is satisfied, then A is a consistent array, the rank of A is 1, and the unique nonzero eigen-root of A is n, and the eigenvector corresponding to the nonzero eigen-root n is normalized as a weight vector. Then:

$$Aw = nw \tag{2}$$

where, w is the eigenvector corresponding to the eigenroot value n.

If A is an inconsistent contrast array, find the largest eigenroot $\lambda_{\max}$ of matrix A, and find the corresponding eigenvector according to the largest eigenvalue $\lambda_{\max}$, $Aw = \lambda_{\max} \cdot w$. After normalization, it is used as the ranking weight of the indicator factor importance.

The greater the degree of inconsistency of A, the greater the error in causing the judgment. It is necessary to test the consistency of the matrix A, the test formula:

$$CI = \frac{\lambda_{\max} - n}{n - 1} \tag{3}$$

Consistency Indicator:

$CI = 0$, there is perfect consistency; CI is close to 0, there is satisfactory consistency; the larger CI is, the more serious the inconsistency is. To measure the magnitude of CI, the random consistency index RI is introduced.

Ratio of consistency:

$$CR = \frac{CI}{RI} \tag{4}$$

Generally, when the consistency ratio $CR < 0.1$, the inconsistency of the corresponding comparison matrix A is considered to be within acceptable limits, and its corresponding eigenvectors are normalized as the weight vectors of the evaluation factors of the performance indexes; otherwise, the comparison matrix needs to be adjusted by elimination until the consistency requirement is met.

II. B. 2) FCE-based parameter tuning

The Fuzzy Comprehensive Evaluation (FCE) method is a scientific method that relies on fuzzy mathematical theory. The steps of this method are as follows:

First of all, based on the evaluation index system of college students' employability under different focus dimensions constructed in the previous chapters, we establish the influence factor sets X and Y, which represent

the set of influence indexes of extrinsic core ability and the set of influence indexes of intrinsic core ability, respectively. Taking the internal core competence of college students as an example, the set of main influence indicators is set as $X=\{X_1,X_2,X_3\}$, and the subset of the three indicators is set as $X_i=\{X_{i1},X_{i2},X_{i3}\}$.

Next, the evaluation score table is established. In practical applications the evaluation level is often divided into five levels, i.e., poor, poor, average, better and good, corresponding to scores 1, 2, 3, 4 and 5 respectively, and then questionnaires are distributed to the audience in the relevant fields for scoring, and the fuzzy evaluation matrix D_i for the single-factor indicator X_i is constructed:

$$D_i=\begin{bmatrix} r_{11} & r_{12} & \cdots\cdots & r_{1i} \\ r_{21} & r_{22} & \cdots\cdots & r_{2i} \\ \cdots\cdots & \cdots\cdots & \cdots\cdots & \cdots\cdots \\ r_{i1} & r_{i2} & \cdots\cdots & r_{ii} \end{bmatrix}(i=1,2,3,4) \tag{5}$$

Finally, the fuzzy comprehensive evaluation is carried out. Firstly, the first level of comprehensive evaluation is carried out, based on the weights W_i of the factors of college students' employability evaluation indicators determined by hierarchical analysis method, construct the weight set $W_i=\{W_1,W_2,W_3\}$, multiply the evaluation matrix D_i with the corresponding W_i is multiplied to derive the composite evaluation vector A_i for the indicator X_i with $A_i=W_i\times D_i=\{A_{i1},A_{i2},A_{i3},A_{i4}\}$.

Then the comprehensive evaluation of the second-level indicators is carried out, and the second-level fuzzy evaluation matrix is constructed by considering $A_i(i=1,2,3)$ as mutually independent factors. By multiplying this matrix with the corresponding set of criterion level weights, the second level comprehensive evaluation vector is derived. The adjustment parameter K is then calculated based on the scores corresponding to each level.

III. Comprehensive assessment and analysis of the employability of university students

III. A. Determination of the weights of the indicator system

Weight is a measure of the importance of the indicators and has a key impact on the scientificity and effectiveness of the evaluation. On the basis of fully considering the limitations of various methods of determining weights, according to the steps of AHP, expert opinions were solicited, the judgment matrix of each indicator was scored and passed the consistency test of single sorting and total sorting, and the weights of the indicators were finally determined, and the weights of these indicators were synthesized to get the final weights of the comprehensive evaluation index system of college students' employment ability, as shown in Table 2. In the dimension of extrinsic core competence, the weights of specialized knowledge X1 and specialized knowledge and comprehension X2 are 0.250 and 0.750, and the communication ability X04 and teamwork ability X03 are the largest among them, which are 0.223 and 0.198. In the dimension of intrinsic core competence, the weights of self-efficacy X3, metacognition X4, and work adaptation and development X5 are 0.413, respectively, 0.182 and 0.405, the situation is more valued in the students' self-efficacy and work adaptation and development abilities.

Table 2: The weight of the evaluation index of college students' employment ability

Dimension	Primary indicator	Secondary indicator	Weight
External core capacity	Professional knowledge and understanding X1(0.250)	X01	0.130
		X02	0.120
	Practical skill X2 (0.750)	X03	0.198
		X04	0.223
		X05	0.105
		X06	0.087
		X07	0.138
Inner core capacity	Self-efficacy X3 (0.413)	X08	0.089
		X09	0.111
		X10	0.104
		X11	0.060
		X12	0.050
	Metacognition X4(0.182)	X13	0.061
		X14	0.120
	Job adaptation and development X5(0.405)	X15	0.110
		X16	0.071
		X17	0.097
		X18	0.128

III. B. Empirical analysis

III. B. 1) Objects of evaluation

This study measures the employability of college students, and the samples selected are from some colleges and universities in a province. Distributed through the network questionnaire, a total of 600 questionnaires were collected and 537 questionnaires were valid, with an effective rate of 89.5%. Among them, the number of male students accounted for 52.33% and the number of female students accounted for 47.67%.

III. B. 2) Questionnaires

Based on the self-developed evaluation tool - the comprehensive evaluation index system of college students' employability, this study designed a questionnaire for the comprehensive evaluation of college students' high-quality employability with reference to different scales and questionnaires for each index, which involved 5 dimensions and 18 indicators of the index system, with a total of 35 questions, and adopted a 5-level evaluation standard to comprehensively evaluate the employability of college students. In order to ensure the validity of the questionnaire, a pre-test was conducted before the distribution of the questionnaire, in which a total of 25 university students participated, and the results passed the validity and reliability tests. On this basis, a wide range of questionnaires were distributed. The results of the questionnaire were processed and analyzed through the constructed model, mainly for the overall level of college students' employability, the significance of different groups, and the correlation of the surveyed college students' employability.

III. B. 3) Evaluation of employability

According to the design of the relevant questionnaire, the specific evaluation of college students' employment ability, 537 respondents to the evaluation of the evaluation index system in the sub-criteria level indicators, the set of comments for {poor, poor, average, better, good}, the set of comments corresponding to the rank specific score were {1, 2, 3, 4, 5}, and the specific evaluation questionnaire results are collated to get the specific scoring results. The distribution of the number of people evaluating each index under the dimension of extrinsic core competence and intrinsic core competence is shown in Figure 1 and Figure 2. Most of the respondents in the questionnaire survey chose “poor”, “average”, “good”, and fewer respondents chose “good”. On this basis, the evaluation method proposed in this paper is used to calculate the scores of the indicators of college students' employability under the two dimensions, and the evaluation results of college students' employability are shown in Table 3. Under the dimension of extrinsic core competence and intrinsic core competence, the comprehensive scores of the evaluation of college students' employment ability are 2.530 and 2.599, which are between poor and average, so the evaluation of the employment ability of the sample college students is not high. Under the dimension of extrinsic core competence, the scores of specialized knowledge X1 and specialized knowledge and understanding X2 are 2.853 and 2.423. Under the dimension of intrinsic core competence, the scores of self-efficacy X3, metacognition X4, and job adaptation and development X5 are also between 2.5 and 3.0. Among them, the score of specialized knowledge X01 is above 3, which is relatively good for college students' specialized knowledge mastery.

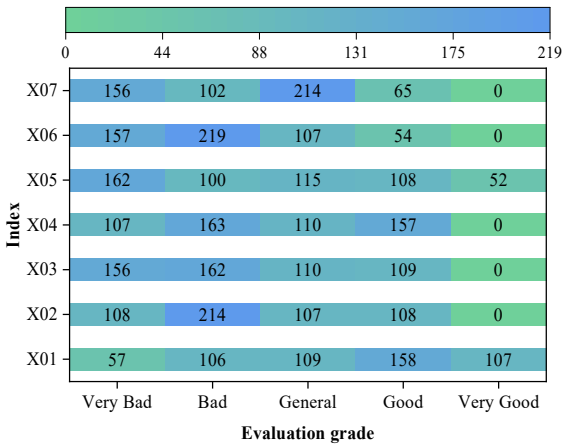

Figure 1: The distribution of indicators under the external core competence dimension

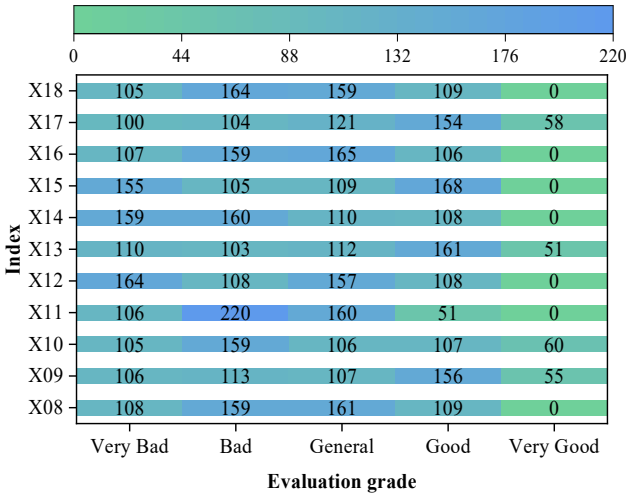

Figure 2: The distribution of indicators under the inner core competence dimension

Table 3: Evaluation results of college students' employment ability

Dimension	Primary indicator	Secondary indicator	Score
External core capacity (2.530)	Professional knowledge and understanding X1(2.853)	X01	3.28
		X02	2.40
	Practical skill X2 (2.423)	X03	2.32
		X04	2.59
		X05	2.61
		X06	2.11
		X07	2.35
Inner core capacity (2.599)	Self-efficacy X3 (2.624)	X08	2.50
		X09	2.89
		X10	2.74
		X11	2.29
		X12	2.39
	Metacognition X4(2.503)	X13	2.89
		X14	2.31
	Job adaptation and development X5(2.617)	X15	2.54
		X16	2.50
		X17	2.94
		X18	2.51

III. B. 4) Analysis of differences

In order to gain a deeper understanding of whether there is a significant difference between college students' types, majors, education levels, and whether or not they participate in the workforce in the various dimensions of employability, this study conducted a significance test, and the indicators of significant differences in employability are shown in Figure 3. When the significance is less than 0.05, it indicates that there is a significant difference in the indicator in the corresponding classification, and the purple dotted line in the figure indicates that the significance = 0.05.

The indicators of each dimension show significant differences in different categories. There were significant differences in the competencies of "majors" in all aspects, "university nature" in 13 competencies, "education level" in 6 competencies, "work experience" in 7 competencies, and "unit nature" in 8 competencies. This not only shows that there are great differences in the employability of college students in different colleges and universities and different majors, but also reflects the differences in talent training in colleges and universities. In addition, the level of education, work experience and the nature of the unit have a great impact on the employability of college students.

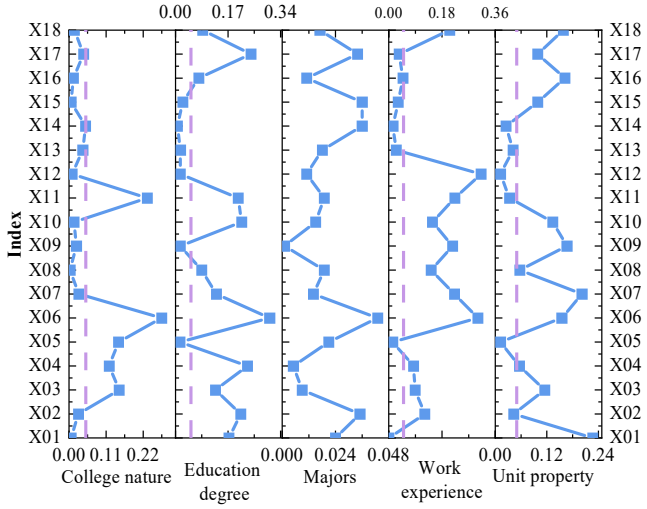

Figure 3: Significant difference in employment ability

IV. Strategies for improving the employability of college students

Employment is related to economic and social development and stability and harmony, and how to promote high-quality employment is an urgent problem for colleges and universities. Combined with the above comprehensive assessment of college students' employability, we discuss the path of improving college students' employability.

IV. A. Positive change of mindset and engagement in practice

IV. A. 1) Changing the concept of employment

On the one hand, it is to change the traditional concept of employment. College students should follow the principle of realism in choosing employment, including two aspects: (1) the realism of the external career environment, (2) the realism of the quality of personal ability. College students can systematically learn the knowledge of career planning, fully understand the current national economic development situation and employment prospects, and form an objective perception of themselves.

IV. A. 2) Participation in practical exercises

On the other hand, it is to actively participate in practical exercises. Practical exercise can help college students to promote the mastery of professional skills and understanding of professional knowledge. College students can actively participate in subject competitions, volunteer activities, scientific research and other practical activities after school to exercise practical skills, but also in teamwork to exercise their communication and collaboration skills, by participating in the summer and winter vacations in the countryside and corporate internships, to help themselves to broaden their horizons and increase their insights, not only to deepen their understanding of the development of the industry and the content of the work of the job, to promote their career thinking, but also to reflect on their own lack of ability and skills against the requirements of the job capacity, targeted to improve their own during the university period. The internship not only can deepen the knowledge of the industry development and job content, promote their career thinking, but also can check their own lack of ability and skills against the requirements of the job ability, and improve their quality during the university period in a targeted manner, so as to reach the working ability required by the current target job, and comprehensively improve their employability.

IV. B. Optimizing educational models and career guidance

IV. B. 1) Optimizing educational models

Colleges and universities should optimize the education mode, enhance the proportion of practical teaching in the courses, and provide students with more practical opportunities to help them better master theoretical knowledge and enhance their competitiveness in employment. For example, more experimental courses can be provided to science and engineering students to help students understand theories and exercise skills in experiments, and for liberal arts students, more social practice opportunities can be provided to allow students to go out of the classroom and get in touch with the society. In addition, colleges and universities should adjust and update the curriculum and course teaching content to adapt to the changing market environment and social development needs, and ensure that the course content is compatible with social needs. In addition, colleges and universities

can investigate and understand the learning needs of students and the needs of career development, improve the design of the curriculum, and make the teaching closer to reality.

IV. B. 2) Optimizing career guidance

In the cultivation of the employment guidance workforce, it is necessary to strengthen the training of teachers on the mastery of employment knowledge and skills, and improve the level of the faculty, such as carrying out lectures by experts, organizing regular exchange seminars on employment work, sharing experiences and methods, and improving the quality of education and teaching and employment guidance, as well as inviting the human resources managers of off-campus enterprises and vocational tutors to participate in the employment guidance work of the school, providing resume writing, interview guidance and job-seeking advice, and so on, both inside and outside the school. The school has also invited human resource managers of off-campus enterprises and career mentors to participate in the school's employment guidance work, providing resume writing, interview guidance and job-seeking advice for college students.

IV. C. Strengthening school-enterprise cooperation

Colleges and universities should deepen their cooperation with enterprises, and colleges in particular should establish long-term and stable cooperative relationships with leading enterprises in the industries targeted for employment of graduates of the various majors in their colleges, signing agreements and building student training bases together.

In terms of curriculum and practice integration, according to the recruitment requirements of enterprises and the actual faculty and resources of colleges, the two sides will jointly design the curriculum, integrate the knowledge and technology needed by enterprises to carry out their work into the teaching content, and promote the effective docking between talent cultivation and market demand.

In terms of project cooperation, after college students have completed the study of professional knowledge and skills according to the training plan, enterprises provide apprenticeship positions to colleges and schools, so that students can participate in the real project work of the enterprises, accumulate real work experience, accelerate the improvement of students' adaptability to their positions, and help college students enhance their employability.

In terms of system construction, an enterprise mentor system has been established, whereby off-campus enterprise experts are appointed as students' career planning and job-seeking mentors to provide professional guidance and advice, and regular lectures are held to share with college students industry development trends, the latest technology concepts and personal career development suggestions.

In terms of building an employment information platform, the university and enterprises have established a perfect employment information transmission channel to dock the job-seeking needs of college students with the employment needs of enterprises, and timely release information on enterprise positions to help college students find positions that match their skills, abilities and interests.

V. Conclusion

This study systematically evaluates the employment ability of college students by constructing the AHP-FCE comprehensive assessment model, and finds that the overall level of current college students' employment ability needs to be improved. The assessment results show that the score of extrinsic core competence is 2.530, and the score of intrinsic core competence is 2.599, neither of which reaches a good level. In the composition of specific competencies, the mastery of professional knowledge is relatively good, with a score of 3.28, while the communication ability is only 2.59 and the teamwork ability is 2.32, reflecting that there is an obvious shortcoming of college students in terms of soft skills. Difference analysis shows that professional background has the most significant impact on employability, showing differences in all dimensions, and the nature of colleges and universities has significant differences in 13 ability dimensions, indicating that there is a big gap in the effect of talent cultivation in different types of colleges and universities.

Based on the assessment results, diversified strategies should be adopted to enhance the employment ability of college students. Individuals need to change the traditional concept of employment, actively participate in practical exercises, and improve their comprehensive quality through disciplinary competitions, volunteer services and other activities. Colleges and universities should optimize the education mode, increase the proportion of practical teaching, improve the career guidance system and build professional guidance teams. The integration of industry and education should deepen the cooperation between schools and enterprises, build training bases, realize the deep integration of curriculum and practice, establish the enterprise mentor system, and build an employment information platform. Only through the concerted efforts of students, colleges and universities and enterprises can we effectively improve the employability of college students and realize the goal of high-quality employment.

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