THE APPLICATION OF ANALYTIC HIERARCHY PROCESS IN THE EVALUATION OF COLLEGE STUDENTS' INNOVATION AND ENTREPRENEURSHIP ABILITY

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ABSTRACT

The evaluation of college students' innovation and entrepreneurship ability is comprehensive and fuzzy. In this paper, an evaluation index system of college students' innovation and entrepreneurship ability is constructed by using analytic hierarchy process, to carry out quantitative analysis on the evaluation of college students' innovation and entrepreneurship ability. This study takes Yibin University as the research object. Firstly, the evaluation of college students' innovation and entrepreneurship ability is taken as the target layer, and then three criterion layers are constructed, finally, plan layers (11 indicators) are constructed as evaluation indexes of college students' innovation and entrepreneurship ability. The analytic hierarchy process (AHP) is used to calculate the final weight of each index, as well as the composite weight of each layer element to the target layer element, and the ranking is carried out to make the corresponding decision, which provides reference for the performance evaluation of the cultivation of college students' innovation and entrepreneurship ability. The empirical analysis shows that the consciousness of innovation and entrepreneurship ranks first in the system of college students' innovation and entrepreneurship ability which is different from the conventional viewpoints.

Keywords: Analytic hierarchy process, innovation and entrepreneurship, ability evaluation, college students

INTRODUCTION

For a long time, the traditional Chinese education concept holds that the choices faced by college students after graduation are employment, postgraduate entrance examination or going abroad. The talent cultivation goal of college students is limited to research and application, and the whole society and families lack the cultivation of children's innovative spirit, entrepreneurial consciousness and entrepreneurial ability. The employment difficulty of college students has become a social focus. The policy of mass innovation and entrepreneurship proposed by the government is a long-term mechanism to encourage and help college students to start their own businesses and find jobs, which not only broadens the employment scope of college students, but also creates more jobs for the society and stimulates and promotes economic growth and development. However, the success rate of college students is only 2% to 3%, accounting for only 10 percent of successful start-ups. There are many influencing factors, but the key factor is the innovation and entrepreneurship ability of college students (Zhu Ying, 2020). An accurate and objective evaluation of college students' innovation and entrepreneurship ability can not only help college students understand themselves correctly, grasp employment and entrepreneurship opportunities and reduce opportunity costs, but also adjust the cultivation mode of college

students' innovation and entrepreneurship ability, improve teaching methods and means and improve teaching quality according to the evaluation results. In the talent development strategy of the new era, higher requirements are put forward for talents' practical ability and innovation and entrepreneurship ability (He Dandan et al., 2018). Strengthening innovation and entrepreneurship education for college students is undoubtedly the best way to alleviate the current employment difficulties. From the perspective of sustainable development and employment rate guarantee, colleges and universities should seize their advantages in innovation and entrepreneurship education, strengthen the combination of "industry-university-research" education, and train more applied talents with innovation and entrepreneurship ability. As the most energetic and creative group, it has become a hot topic in China's higher education reform to cultivate the innovation and entrepreneurship ability of college students and promote innovation and entrepreneurship education. Through the literature review, it was found that the current research mainly focuses on the cultivation mode of innovation and entrepreneurship education from the perspective of universities; There is no effective evaluation mechanism for the performance of innovation and entrepreneurship education, that is, the innovation and entrepreneurship ability of college students, which leads to the assimilation of education models, the lack of targeted training, and the innovation and entrepreneurship education becoming a mere formality (Chen Ying, 2019).

Therefore, this paper takes Yibin University as the research object. On the existing literature of innovation and entrepreneurship education, the evaluation indicators of college students' innovation and entrepreneurship ability are sorted out and screened. Through interviews with teachers and discussions with students, the evaluation indicators of college students' innovation and entrepreneurship ability are determined. Establish the evaluation system of college students' innovation and entrepreneurship ability by Analytic Hierarchy Process (AHP). AHP is an often-used procedure to solve strategic decision problems in theory and reality (Wolfgang Ossianic et. al., 1999). It was suggested by Saaty (1980) and called AHP. This method allows us to determine the weights (significances) of hierarchically non-structured or hierarchical level criteria in respect of those belonging to a higher level (Valentinas Podvezko, 2009). Through empirical analysis, this paper evaluates the innovation and entrepreneurship ability for students in Yibin University and tries to fully reflect the real situation of the innovation and entrepreneurship ability of college students, to provide reference for the innovation and entrepreneurship education of college students.

LITERATURE REVIEW

Today, with the rapid development of "Internet plus", enterprises and social organizations often need compound and comprehensive quality talents. They also require talents not only to have professional skills and abilities, but also to have "Internet plus" thinking and development ability, Li Xinyu (2020) pointed out that colleges and universities need to establish and improve a systematic training system for innovation and entrepreneurship, so that students can master professional knowledge in the learning process and set high standards for them with "Internet plus". Based on fuzzy analytic hierarchy process, Chen Yaqiong (2019) evaluated and studied college students in science and engineering from five aspects: social adaptability, independent learning, independent entrepreneurship, independent development, and innovation reform. He Hui et al. (2019) used factor analysis method to study the evaluation index system of entrepreneurial ability of college students in the capital and believed that entrepreneurial knowledge and general entrepreneurial ability were the most important for the evaluation of entrepreneurial ability of college students. Liu Xuebing et al. (2019) believe that entrepreneurial ability, entrepreneurial quality and entrepreneurial consciousness can best reflect the real level of college students' entrepreneurial ability. Yang Yan et al. (2009) studied the application of TRIZ method in the

evaluation of college students' innovation ability, overcoming the influence of subjective weight assignment in existing models on the evaluation results. Zhang Yongmei et al. (2008) developed an evaluation system for college students' scientific and technological innovation ability based on participation in scientific and technological innovation activities and awards in innovation competitions. Shen Ming (2019) established a composite evaluation method for college students' innovation and entrepreneurship ability by using rough set theory and extension theory in coordination with the four levels of innovation and entrepreneurship environment, education, practice and results as the focus.

Through the analysis and study of these relevant literatures, it was found that the current evaluation index system and methods of college students' innovation and entrepreneurship ability present the following deficiencies: First, the concept is vague. The connotation and characteristics of innovation and entrepreneurship are not well understood, and the relationship between innovation and entrepreneurship is confused, resulting in a vague concept. Second, evaluation lacks induction. Either the evaluation index is complex, or the evaluation process is tedious, which is not conducive to popularization and use, or the evaluation method has a great subjective influence, or the evaluation index is fuzzy and cannot be measured qualitatively. Most of the personality qualities in the evaluation indexes are formed before the higher education stage and should not be completely included in the innovation and entrepreneurship education stage in colleges and universities. Third, the orientation is misplaced. Overemphasis on theoretical demand orientation and neglect of practical innovation and entrepreneurship application needs, resulting in non-standard evaluation index system. Fourth, the science is poor. The word meaning of evaluation index is similar and the repetition degree is high, resulting in the evaluation result is not scientific. Although our university has initially established an evaluation system for innovation and entrepreneurship ability and carried out the effect evaluation, the detection effect is not sustainable and scientific due to many problems mentioned above. Analytic hierarchy process (AHP) can deal with the characteristics of uncertain and imprecise data, to obtain more objective index weight value (Mahsa Razavi Davoudi et. al., 2012). It allows for a calculation of a consistency index for the prioritization. This opportunity arises from the fact that AHP is based on all pair-wise comparisons of whatever we would like to prioritize. Also, this fact causes more accurate results of AHP than other methods (Danesh et. al., 2009). Combined with the evaluation characteristics of coordination quality and quantity of hierarchy theory, the advantages and characteristics of hierarchy analysis theory are applied in different stages of the evaluation process, and based on this, the evaluation system of college students' innovation and entrepreneurship ability is constructed. College students' innovation and entrepreneurship ability can be improved to a certain extent, which requires a scientific and objective evaluation system, the comprehensive evaluation of the innovation and entrepreneurship ability of college students is carried out, the evaluation indicators and results are of great importance to the follow-up implementation of innovation and entrepreneurship education, adjustment of work mode, direction, focus and follow-up investment.

RESEARCH METHOD

The Analytic Hierarchy Process (AHP) is proposed by Saaty, a famous American operational research scientist. AHP is a systematic and hierarchical analysis method combining qualitative and quantitative analysis, and it is also a practical decision analysis method. It divided the problems to be analyzed into different components and gathers and combines these factors according to the progressive and subordinate relationship to form a multi-level analysis structure model, by pair-wise comparison of the importance of elements at the same level, a judgment matrix is constructed to calculate the weight of the relative importance order of elements at each level and determine the weight ordering of elements.

Finally, the total weight of elements at each level to the overall goal is calculated to provide a quantitative basis for decision-making (Chen Ying, 2019). The main steps of this method are as follows:

a) According to hierarchical division of each associated element involved in the problem to be solved, forming a hierarchical structure model composed of target layer, criterion layer and scheme layer.
b) Using the mathematical method of judgment matrix and matrix operation to compare the elements of the same level in pairs, calculate the relative weight and judge the relative importance of each element.
c) Verifying the consistency of judgment matrix to ensure the scientific and reasonable results of hierarchy analysis.
d) Calculating the composite weight of elements of each layer to elements of the target layer and sort them to make corresponding decisions.

Constructing the hierarchical structure model

College students' innovation and entrepreneurship ability is composed of many factors. According to relevant literature research and combined with the actual situation of Yibin University, through interviews and discussions with college students' entrepreneurs, college experts, teachers and students, the evaluation index of college students' innovation and entrepreneurship ability is determined, which is divided into three-level evaluation index system according to the hierarchical structure of analytic hierarchy process. The target layer is college students' innovation and entrepreneurship ability (A); the criterion layer includes three parts: innovation and entrepreneurship consciousness (B1), innovation and entrepreneurship skills (B2) and innovation and entrepreneurship management ability (B3). Indicator layer (C) consists of 11 three-level indicators, C11 for innovation and entrepreneurship, C12 for learning ability, C13 for self-confidence, C21 for risk bearing ability, C22 for grasp opportunities, C23 for practice ability, C24 for market development ability, C31 for team organization ability, C32 for enterprise operation ability, C33 for strategic decision-making ability and C34 for financial management ability. As shown in Figure 1, the hierarchical structure model of innovation and entrepreneurship capability evaluation established in this paper is shown in Figure 1.

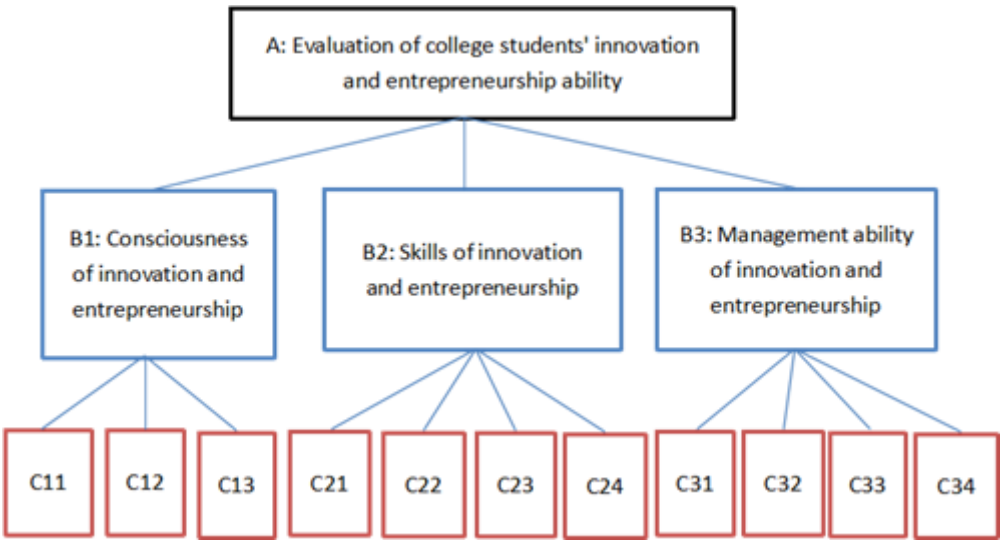

Figure 1: The hierarchical structure model of innovation and entrepreneurship capability

Constructing pairwise comparison matrix

Starting at level 2 of the hierarchy model, for factors at the same level that are subordinate to (or influence) each of the factors at the next level. Pair-comparison matrix is constructed

by pair-comparison method and 1-9 comparison scale until the lowest layer (Guo Hongwei et al., 2010). Table 1 shows the Saaty comparison scale and its interpretation.

Table 1: 1-9 Comparison scale and interpretation

Definition	Scale	Interpretation
Equal importance	1	Two indicators have equal importance
More important	3	Two indicators, one is slightly more important than the other, otherwise, it is 1/3.
Obviously important	5	Two indicators, one is obviously important than the other indicator, otherwise, it is 1/5
Very important	7	Two indicators, one is very important than the other indicator, otherwise, it is 1/7
Absolutely important	9	Two indicators, one is absolutely important than the other indicator, otherwise it is 1/9
The importance is between two adjacent odd numbers	2,4,6,8	Represents the intermediate value of the above adjacent judgments

Calculating weight vector and testing consistency

The weight vector and testing its consistency can be done using the following procedures:

1) Calculating the consistency index CI. It can be calculated by the following formula. N is the order of the matrix. Cl is a standard to measure the inconsistencies of comparative judgment matrices.

   $CI=\frac{\lambda max-n}{n-1}$

2) Searching for the average random consistency index RI. The values of RI are shown in Table 2.

Table 2: Average random consistency index

Matrix order	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

3) Calculating the random consistency ratio CR. It can be calculated by the following formula: When CR< 0.1, the comparison judgment matrix has satisfactory consistency, and its feature vector can be used as weight vector. Otherwise, it is necessary to readjust the comparative judgment matrix until a satisfactory consistency is achieved.

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

4) The combination weight vector and testing the combination consistency can be calculated as such:
   Compute the combined weight vector of the lowest level to the target. The combination consistency test is done according to the formula. The calculation formula of each component of the total ranking weight vector is as follows:

$$W_i = \sum_{j=1}^{m} b_j c_{ij} (i = 1,\ldots,n)$$

5) The calculation formula of total ranking random consistency index is as follows:

$$CR = \sum_{j=1}^{m} b_j CI \,/\, \sum_{j=1}^{m} b_j RI_j$$

When CR is less than 0.1, the hierarchical total ranking is good. Otherwise, the comparative judgment matrix should be readjusted.

SAMPLING

This study conducted a questionnaire survey among 67 college students in Yibin University. The sampling method was cluster sampling, and students from three colleges were randomly sampled: That is, the Faculty of Education (13), the Faculty of Art (28) and the Faculty of Economics and Management (26). According to the regulations of the university, all students must attend the courses of innovation and entrepreneurship education. Therefore, the students of the three colleges receive the same education mode, but the difference lies in the different management modes of the colleges and the individual differences of students within the group.

FINDINGS AND DISCUSSION

College students' innovation and entrepreneurship ability evaluation index system is a complex system composed of multiple level indicators, using the analytic hierarchy process to evaluate college students' innovation and entrepreneurship ability, determine the respective weights of each index in the whole evaluation system, is to ensure that the evaluation index system and method can work correctly, and that is the primary key step to solve.

Establishing an evaluation system for college students' innovation and entrepreneurship ability

This section discussed college students' innovation and entrepreneurship ability.

Consciousness of innovation and entrepreneurship
College students are the focus and subject of innovation and entrepreneurship education activities, and their innovation and entrepreneurship spirit, learning ability and confidence are the most important indicators to test the ability of innovation and entrepreneurship.

Innovation and entrepreneurship skills
In the process of innovation and entrepreneurship, college students need to have certain risk bearing ability, the ability to grasp market opportunities, practical ability and certain market development ability.

Innovation and entrepreneurship management ability
Team organization is a very important factor for the success of college students' innovation and entrepreneurship, and certain enterprise operation ability, strategic decision-making ability and financial management ability are essential factors. In combination with the innovation and entrepreneurship education project of Yibin University, the evaluation system of college students' innovation and entrepreneurship ability is developed as shown in Table 3.

Table 3: Evaluation system of college students' innovation and entrepreneurship ability

Target layer A	Criteria layer B	Scheme layer C
College students' innovation and entrepreneurship ability	B1: Consciousness of innovation and entrepreneurship	C11: Innovation and entrepreneurship
		C12: Learning ability
		C13: Confidence
	B2: Innovation and entrepreneurship skills	C21: Risk bearing ability
		C22: Ability to grasp opportunities
		C23: Practical ability
		C24: Market development ability
	B3 : Innovation and entrepreneurship management ability	C31: Team organization ability
		C32: Enterprise operation ability
		C33: Strategic decision-making ability
		C34: Financial management ability

Constructing comparative judgment matrix

According to the construction method of comparative judgment matrix, each specific evaluation scheme in the evaluation system of college students' innovation and entrepreneurship ability was used to form a questionnaire based on Saaty's 9-scale method, and the questionnaire was submitted to innovation and entrepreneurship teachers for review, then the questionnaire was distributed, and finally the collected data were summarized and sorted out to obtain several pairwise comparative judgment matrices of each evaluation level. Table 4-7 shows the calculation results.

Hierarchical single ordering and consistency test

The maximum eigenvalue λ_{max} and corresponding eigenvector (weight vector) W_0 of each comparison judgment matrix are calculated by Matlab7.0. Formula (1) and formula (2) are used to calculate consistency index CI and random consistency ratio CR respectively. And the consistency can be tested by CR value. When CR<0.1, the comparative judgment matrix is considered to have good consistency. Its eigenvectors can be used as weight vectors. Otherwise, it is necessary to readjust the comparative judgment matrix until a satisfactory consistency is achieved. Table 4-7 shows the calculation results.

Table 4: Index weight and consistency test of matrix A-B_i

A	**B_1**	**B_2**	**B_3**	**Weight Vector w_0**	**Index**
B_1	1	2	4	b_1=0.558	λ_{max}=3.018
B_2	1/2	1	3	b_2=0.320	CI=0.009
B_3	1/4	1/3	1	b_3=0.122	CR=0.016‹0.1

Table 5: Index weight and consistency test of matrix B1-C1j

B_1	**C_{11}**	**C_{12}**	**C_{13}**	**Weight Vector w_0**	**Index**
C_{11}	1	3	3	c_{11}=0.589	λ_{max}=3.053
C_{12}	1/3	1	2	c_{12}=0.252	CI=0.027
C_{13}	1/3	1/2	1	c_{13}=0.159	CR=0.046‹0.1

Table 6: Index weight and consistency test of matrix B2-C2j

B_2	**C_{21}**	**C_{22}**	**C_{23}**	**C_{24}**	**Weight Vector w_0**	**Index**
C_{21}	1	3	5	7	c_{21}=0.581	λ_{max}=4.059
C_{22}	1/3	1	2	4	c_{22}=0.235	CI=0.019
C_{23}	1/5	1/2	1	1	c_{23}=0.103	RI=0.90
C_{24}	1/7	1/4	1	1	c_{24}=0.081	CR=0.021‹0.1

Table 7: Index weight and consistency test of matrix B3-C3j

B_3	C_{31}	C_{32}	C_{33}	C_{34}	Weight Vector w_0	Index
C_{31}	1	2	3	4	c_{31}=0.460	λ_{max}=4.072
C_{32}	1/2	1	2	4	c_{32}=0.298	CI=0.024
C_{33}	1/3	1/2	1	1	c_{33}=0.134	RI=0.90
C_{34}	1/4	1/4	1	1	c_{34}=0.108	CR=0.027<0.1

Hierarchical total ranking and overall consistency test

The sorting vector of criterion layer (B) relative to target layer (A) is calculated by hierarchical single sorting, and the weight of index layer relative to criterion layer, among them, the total ranking of index layer relative to target layer can be calculated by formula (3) and (4). When CR<0.1, it is considered that the hierarchical total ranking results have good consistency. Otherwise, the comparative judgment matrix should be readjusted. The results are shown in Table 8. It can be seen from Table 8 that all judgments have overall consistency through the consistency test of hierarchical total ranking.

Table 8: Hierarchical total sorting results

Criterion layer	**B_1**			**B_2**				**B_3**			
Weight	0.558			0.320				0.122			
Target layer	C_{11}	C_{12}	C_{13}	C_{21}	C_{22}	C_{23}	C_{24}	C_{31}	C_{32}	C_{33}	C_{34}
Hierarchical single ordering	0.589	0.252	0.159	0.581	0.235	0.103	0.081	0.460	0.298	0.134	0.108
Hierarchical total ordering	0.329	0.141	0.089	0.186	0.075	0.033	0.026	0.056	0.036	0.016	0.013
CI=0.024 ; RI=0.721 ; CR=0.033 < 0.1											

CONCLUSION

This paper uses analytic hierarchy process to calculate the weight of each index in the evaluation index system of innovation and entrepreneurship ability of students in Yibin University. As an example, a method to solve the problem is introduced. It can be seen from the overall ranking results in Table 8 that the most important thing for students to judge the innovation and entrepreneurship ability of college students is the consciousness of innovation and entrepreneurship, which has a weight of 0.558 relative to the overall goal. The second is innovation and entrepreneurship skills and innovation and entrepreneurship management ability, with weights of 0.320 and 0.122 respectively. This result is consistent with the objective fact of innovation and entrepreneurship of students in Yibin University. Since the training goal of the innovation and entrepreneurship education courses of Yibin University is to improve the innovation and entrepreneurship consciousness and ability of college students, and the main goal is to cultivate the theoretical knowledge of college students, the study of the innovation and entrepreneurship education courses of Yibin University is to cultivate the innovation and entrepreneurship thinking of college students. However, in the field of practical experience learning, the foundation is relatively weak, so in the field of practice, teachers and hardware investment and efficiency should be increased to make up for this deficiency. According to the questionnaire, the top 5 students' innovation and entrepreneurship ability are innovation and entrepreneurship spirit, learning ability, risk bearing ability, team organizing ability and enterprise operation ability. The cultivation of

these abilities coincides with the goal of innovation and entrepreneurship education of Yibin University. 70% of the students in Yibin University come from rural areas, and the economic foundation for innovation and entrepreneurship is weak. Most of them choose to find jobs after graduation and start businesses when they have certain economic capacity. Therefore, the survey results show that the entrepreneurship rate of Yibin University is only 2%, which is consistent with the objective fact. How to cultivate college students' consciousness of innovation and entrepreneurship will be further studied in the future.

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