

# A Study on the Factors of College Students' Innovation and Entrepreneurial Ability Through Analytic Hierarchy Process

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The number of college graduates has been increasing year by year and, subsequently, the pressure to secure employment pressure is greater. Hence, the entrepreneurship of college students and their ability to become innovators, can not only solve their employment problems, but also create more jobs for their peers. The innovation ability and entrepreneurship of college students after graduation need to be supported. In this study, the analytic hierarchy process (AHP) method was applied to determine the factors affecting the innovation and entrepreneurship ability of college students. An indicator evaluation system model containing three levels and nine indicators was established for the innovation and entrepreneurship ability of college students. The relevant data were collected by questionnaire. The results of the verification process indicated that the data were reliable and usable. A judgement matrix was established for the evaluation indicators in the model. After the consistency check, the weight of the matrix was calculated. The study found that the weight of entrepreneurial ability, innovation ability, and social ability was 0.4257, 0.3961, and 0.1782, respectively. The final results indicate that entrepreneurial ability is the most important factor, innovation ability is the second, and social ability is of the least value.

Keywords: analytic hierarchy process, innovation and entrepreneurship, entrepreneurship of college students

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## 1. INTRODUCTION

The covid-19 pandemic created a complex economic environment, sending numerous micro-enterprises to the verge of bankruptcy or the laying off of employees (Wang et al., 2021), directly leading to a gradual reduction in the number of job opportunities available to graduates. However, the number of college graduates is increasing year by year, leading to an imbalance in the ratio of supply and demand of talents, and placing greater pressure on young people in the employment market. Therefore, the state has called on college students to engage in innovation and entrepreneurship to enable them to address their employment problems and increase the number of jobs in society in general. Schools

have launched corresponding innovation and entrepreneurship course training in response to the call of the state (Sun, 2022). The innovation and entrepreneurship of college students after graduation is one of the main factors that can improve the employment rate. Therefore, it is important to improve the innovation and entrepreneurship of college students as this is very important for the nation's economic development.

Wei conducted research to determine whether the training of innovation and entrepreneurship professionals can improve their entrepreneurial ability, and resolve the problem of innovative companies having difficulty obtaining a foothold in emerging industries, and increase the chances of entrepreneurial success (Wei, 2021).

Li believed that dual innovation was the way to ensure that the country prospered and its people were enriched. He analyzed the innovation and entrepreneurship education

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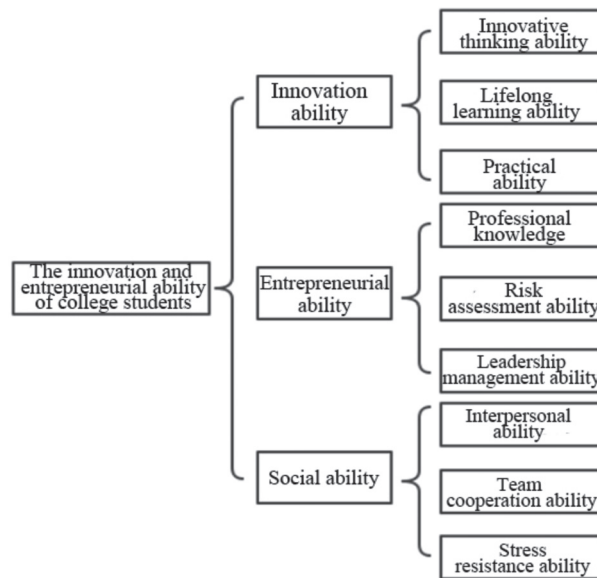


Figure 1 Structure of the indicator system.

offered in secondary vocational schools through literature and logical analyses, and found the future development of dual innovation according to the development requirements of the times (Li, 2021).

Pisoni examined the application of a blended learning model and found that it had a positive impact on student motivation and the development of their innovation and entrepreneurship soft skills (Pisoni, 2019).

By means of questionnaire surveys, observations, and empirical analysis of the collected data, Zhang et al. found that the theoretical model based on artificial intelligence technology could effectively determine those factors influencing college students' willingness to innovate and start a business (Zhang and Fu, 2021).

Li et al. analyzed the entrepreneurship and cultural diversity cultivation of college students based on a combination of theoretical analysis and practical investigation, and found that college freshmen scored poorly on the innovation and challenge dimensions (Li et al., 2021).

In this current study, the analytic hierarchy process (AHP) method was used to analyze the factors influencing the innovation and entrepreneurship ability of college students. A three-level model containing nine influencing factors was constructed, relevant data was collected via questionnaires, and the reliability and validity of the data were confirmed. Moreover, a judgment matrix of influencing factors was established, and the weights of the factors were calculated after the consistency test to find the factors that have the greatest influence on college students' innovation and entrepreneurship ability. This study will provide a theoretical basis and methodological support to improve the innovation and entrepreneurship ability of college students.

## 2. ANALYTIC HIERARCHY PROCESS MODEL

The AHP method (Zhao and Mu, 2022) divides a problem that is difficult to quantify into multiple levels based on the

relationship between its relevant factors and then analyzes its importance with the mathematical model established. The specific modeling steps of the AHP method are as follows.

(1) Build a multi-layer structural model: the AHP method usually divides elements into three layers: objective layer, criterion layer, and indicator layer (Yang et al., 2021). Whether college students engage in innovation and entrepreneurship after graduation and whether they can succeed in innovation and entrepreneurship depend not only on objective factors such as social environment and funding sources but also on the subjective factor—their innovation and entrepreneurship ability. Therefore, the AHP model used in this paper divides the relevant elements into the target layer (A), i.e., innovation and entrepreneurship ability of college students, the criterion layer (B), i.e., innovation ability, entrepreneurial ability, and social ability, and the indicator layer (C), i.e., innovation ability is divided into innovative thinking ability, lifelong learning ability, and practical ability, entrepreneurship ability is divided into professional knowledge, risk assessment ability, and leadership management ability, and social ability is divided into interpersonal ability, team cooperation ability, and stress resistance ability. The specific indicator system structure is shown in Figure 1.

(2) Pairwise comparison is performed on different indicators in the criterion layer. All judgment matrices are established based on the indicator elements in the hierarchy, i.e.,

$$A(a_{ij})_{n \times n} = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix},$$

where  $n$  is the number of indexes.  $a_{ij}$  is the relative importance degree between indicators  $i$  and  $j$ . When  $i = j, a_{ij} = 1$ ; when  $i \neq j, a_{ij} = 1/a_{ji}$ .  $a_{ij}$  is assessed by the nine-scale method (Ginting and Sianturi, 2021), as shown in Table 1.

(3) In order to test the consistency of the judgment matrix, the consistency ratio (CR) is calculated:

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

**Table 1** The nine-scale method and corresponding meanings.

Scale	Meaning
1	Indicator <i>i</i> is equally important than <i>j</i>
3	Indicator <i>i</i> is slightly more important than <i>j</i>
5	Indicator <i>i</i> is significantly more important than <i>j</i>
7	Indicator <i>i</i> is strongly more important than <i>j</i>
9	Indicator <i>i</i> is extremely more important than <i>j</i>
2, 4, 6, 8	Between two adjacent levels of importance

**Table 2** Value of average randomness indicator RI.

<i>n</i>	1	2	3	4	5	6	7	8	9
RI	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46

**Table 3** Results of reliability and validity tests of the influencing factors.

		Cronbach's alpha	KMO value
Innovation ability	Innovative thinking ability	0.912	0.867
	Lifelong learning ability	0.962	0.828
	Practical ability	0.923	0.891
Entrepreneurship ability	Professional knowledge	0.951	0.811
	Risk assessment ability	0.927	0.824
	Leadership management ability	0.917	0.853
Social ability	Interpersonal ability	0.959	0.827
	Team cooperation ability	0.938	0.863
	Stress resistance ability	0.924	0.837

When  $CR < 0.1$ , it indicates that the judgment matrix meets the requirements of the consistency test (Wu et al., 2022); otherwise, the relevant values are checked and adjusted until they pass the consistency test.

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

where  $\lambda_{\max}$  is the maximum characteristic value of the matrix and  $n$  is the number of comparative factors. The average randomness index (RI) (Sharma and Sharma, 2020) is shown in Table 2.

### 3. EXAMPLE ANALYSIS

#### 3.1 Data acquisition

A questionnaire was used to collect data on the factors influencing the innovation and entrepreneurship ability of college students in Shanghai Xingjian College. In addition to the demographic data such as age, gender, education, etc., the questionnaire contained the nine influencing factors that have an impact on the innovation and entrepreneurship ability of college students as established in this study. Since innovation and entrepreneurship need to be demonstrated in practice, only those college students who have actually been engaged in innovation and entrepreneurship can clearly understand the factors that will really affect the improvement of their innovation and entrepreneurship ability. Therefore, the target of the questionnaire was college students who had innovation and entrepreneurship experience after graduation.

Five hundred questionnaires were distributed, and 463 were collected.

#### 3.2 Reliability and Validity Tests

In order to ensure that the data obtained from the questionnaire were credible and valid (Yang et al., 2023), the data were tested for reliability and validity, respectively. The test of reliability adopted the Cronbach's alpha (Matarneh et al., 2019), while the test of validity adopted the Kaiser-Meyer-Olkin (KMO) (Akbari et al., 2020) test. When the Cronbach's alpha was smaller than 0.6, it was generally considered that the reliability of the data was not high; when the value was between 0.8 and 0.9, it indicated that the reliability of the data was good. As shown in Table 3, the Cronbach's alpha of the nine influencing factors were all above 0.9. Generally, when the KMO value was larger than 0.9, the effect was the best; when it was smaller than 0.5, it was not suitable for factor analysis. The KMO values shown in Table 3 were above 0.8, indicating that the validity of the data was very good. Therefore, it was concluded that the reliability and validity of the data obtained from the questionnaire were very good and could be used in the AHP model.

#### 3.3 Process and Result Analysis

After the reliability and validity of the factors influencing innovation and entrepreneurship were verified, an AHP model was constructed based on the nine influencing factors.

**Table 4** Innovation and entrepreneurship ability matrix.

Innovation and entrepreneurship	Innovation ability	Entrepreneurship ability	Social ability
Innovation ability	1	3	1/3
Entrepreneurship ability	1/3	1	1/5
Social ability	3	5	1

**Table 5** Innovation ability matrix.

Innovation capability	Innovative thinking ability	Lifelong learning ability	Practical ability
Innovative thinking ability	1	1/3	1/2
Lifelong learning ability	3	1	2
Practical ability	2	1/2	1

**Table 6** Entrepreneurial ability matrix.

Entrepreneurship	Professional knowledge	Risk assessment ability	Leadership management ability
Professional knowledge	1	1/2	1/3
Risk assessment ability	2	1	1/2
Leadership management ability	3	2	1

**Table 7** Social ability matrix.

Social ability	Interpersonal ability	Team cooperation ability	Stress resistance ability
Interpersonal ability	1	2	3
Team cooperation ability	1/2	1	2
Stress resistance ability	1/3	1/2	1

Moreover, ten experts were invited to judge the evaluation indicators in the model according to their importance using the nine-scale method. The corresponding judgment matrices were constructed, as shown in Tables 4–7.

The maximum characteristic value and weight of every index in the AHP model were calculated based on the statistics of expert scores and questionnaires, and the data obtained from the above judgment matrices, and the research results are shown in Table 8.

Table 8 shows that the consistency test result of the judgment matrix consisting of the three evaluation criteria—innovation, entrepreneurship and social abilities in the criterion layer was 0.0347, which was smaller than 0.1, indicating that the matrix passed the consistency test and the weights calculated by the judgment matrix were acceptable. The weight of innovation ability was 0.3961, the weight of entrepreneurial ability was 0.4257, and the weight of social ability was 0.1782, clearly showing that entrepreneurial ability was the most important innovation and entrepreneurial ability, followed by innovation ability, and social ability was the least important.

The CR value of the judgment matrix consisting of innovative thinking ability, lifelong learning ability, and practical ability under the criterion of “innovation ability” was 0.0497, indicating that the matrix passed the consistency test and the weights calculated by this judgment matrix were valid. The CR value of the judgment matrix consisting of professional knowledge, risk assessment ability, and leadership management ability under the criterion of “entrepreneurship ability” was 0.0465, which meant that the matrix passed the consistency test and the weights calculated by this matrix were valid. The CR value of the judgment matrix consisting

of interpersonal ability, team cooperation ability, and stress resistance ability under the criterion of “social ability” was 0.0392, which meant that the matrix passed the consistency test and the weights calculated by this judgment matrix were valid. The comparison of the weights of the nine evaluation indicators suggested that professional knowledge had the largest weight, 0.4067, stress resistance ability was the second, 0.3895, and innovative thinking ability was the third, 0.3547. These results indicated that these three abilities are the most important to overall innovation and entrepreneurship ability.

#### 4. DISCUSSION

Nowadays, more so than ever before and for various reasons, college graduates are finding it difficult to secure employment. Therefore, college students are being encouraged to engage in innovation and entrepreneurship as a means of resolving the employment issue (Tang and Li, 2021). However, it is very difficult for college students to engage in innovation and entrepreneurship after graduation. In addition to the problems of inexperience and lack of capital, they are also afraid that they do not have the ability to engage in innovation and entrepreneurship (Zhang, 2023). Under the national preferential policies related to innovation and entrepreneurship for college students, the lack of capital is obviously not a problem, but the ability is one of the main reasons determining whether college students can carry out innovation and entrepreneurship and persist with it.

For this study, innovation and entrepreneurship ability was divided into three levels and nine indicators through the AHP method. Questionnaires were used to collect relevant data for

**Table 8** The AHP model of college students' innovation and entrepreneurial ability.

		Weight		CR	Maximum characteristic value
Innovation and entrepreneurship ability	Innovation ability	Entrepreneurship ability	Social ability	0.0347	4.1526
	0.3961	0.4257	0.1782		
Innovative thinking ability	0.3547	/	/	0.0497	4.0367
Lifelong learning ability	0.3092	/	/		
Practical ability	0.3361	/	/		
Professional knowledge	/	0.4067	/	0.0465	4.0314
Risk assessment ability	/	0.3196	/		
Leadership management ability	/	0.2737	/		
Interpersonal ability	/	/	0.2719	0.0392	4.0802
Team cooperation ability	/	/	0.3386		
Stress resistance ability	/	/	0.3895		

the study, and the reliability and validity of the collected data was verified. Ten experts were invited to judge the degree of importance of the indicators according to the nine-scale method. Judgment matrices were established. After passing the consistency verification, the weights were calculated. It was found that entrepreneurial ability was the most important, innovation ability was the second, and social ability was the least. Among the above three levels, professional knowledge was the most important, stress resistance ability (resilience) was the second, and innovative thinking ability was the least. Therefore, according to the weight distribution of the AHP model, the following recommendations are proposed.

1. Schools need to increase the number of courses related to professional knowledge skills and other aspects to strengthen the teaching of professional knowledge to college students. At the same time, the training based on innovation and entrepreneurship courses should be increased to optimize the structure of innovation and entrepreneurship knowledge continuously. The number of platform opportunities available to students for the exchange of innovation and entrepreneurship ideas and advice can be increased by inviting successful entrepreneurs to give lectures at school. Through the questionnaire, it was found that most of the survey participants gave priority to their major field of study when they chose the initial direction of innovation and entrepreneurship after graduation, and combined their professional knowledge with the direction of entrepreneurship. This is because they felt that starting their own business based on their major had more obvious advantages and was faster to get on track.

2. College students constantly need to strengthen their resilience. Entrepreneurship is undoubtedly a process fraught with difficulties and pressure, since entrepreneurs face both internal and external pressures. When the company cannot pay the next month's salary to employees, or the company's business competition is fierce, employees need to be resilient and steadfast. The mindset of the company's leader must be balanced in order to encourage the staff to better persevere.
3. Finally, college students also need to pay attention to the improvement of their innovative thinking ability. Obviously, innovation and entrepreneurship is not the same as the rote memorization of knowledge in colleges; innovation and entrepreneurship require leaders to be creative and lateral thinkers. Innovation is the fundamental force that drives people to progress continuously. Only with innovative thinking will there be a more comfortable development in innovation and entrepreneurship.

## 5. CONCLUSION

This paper briefly introduced the AHP method and the innovation and entrepreneurship ability of college students. The study used the AHP method to analyze the factors influencing the innovation and entrepreneurial ability of college students. The factors were divided into three levels and nine evaluation indicators. The study data were collected by questionnaire and tested for reliability and validity to ensure that they were reliable and usable. The

judgment matrix was established through a nine-scale method, and the weights were calculated after the consistency test to find the factor that has the greatest influence on the innovation and entrepreneurship ability of college students. This study found that: (1) among the innovation and entrepreneurial abilities of college students, entrepreneurial ability was the most important, followed by innovation ability and social ability; (2) the foremost factor among entrepreneurial ability was professional knowledge, the foremost among innovative ability was innovative thinking ability, and the foremost among social ability was resilience.

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