ingegneria sismica
International Journal of Earthquake Engineering
Anno XLIII - Num. 2 - 2026

Exploring the Design and Application of Pattern Recognition Algorithm-Based Innovation and Entrepreneurship Ability Assessment System for College Students in the Perspective of Digital Transformation

Yuming Meng[1,*], *Yibo Li*[2] *and Yuhui Lei*[3]

[1] Trade and Business Administration, Xuchang Ceramic Vocational College School of Economics, Zhengzhou, Henan, 461000, China
[2] Human Resources Department, Zhengyuan University of Science and Technology, Zhengzhou, Henan, 450018, China
[3] School of Art and Design, Zhongyuan University of Science and Technology, Zhengzhou, Henan, 450018, China

SUMMARY: *From the angle of digital decorative things, the method of shape identification gives a fresh idea for the study of an evaluation model for innovation and undertaking abilities.Aiming at the problems such as less hierarchical division of traditional methods, combined with the relevant theories such as fuzzy goals and constraints, a fuzzy comprehensive evaluation model based on pattern recognition is proposed. Its adoption of the closeness method can realize the identification of sample category affiliation, thus making the division effect more scientific and reasonable.In the research on weight distribution and the using of the innovation and entrepreneurship ability evaluation system, it is clearly seen that among the indexes of this evaluation system: the importance degrees of the abilities connected with grabbing opportunities are as below, risk taking, organization management, resource integration, innovation ability and professionalism are 0.14, 0.10, 0.15, 0.19, 0.20, 0.24, etc.The assessment results about the innovation and enterprise-starting abilities obtained by the X organization are shown in the following: the overall scores of grasping opportunities,the score points concerning the capacities of grasping chances, undertaking risks, and making innovations are as the following: those for the capacity to bear challenges and make innovations, the overall scores are: 2.4256, 2.8582, 2.7082 The overall situation is just qualified. The overall scores of resource integration, organizational management, innovation ability and professionalism are 3.3616, 3.2630 and 3.1388 respectively, and the overall situation is relatively strong.*

KEYWORDS: *fuzzy objectives; pattern recognition; evaluation model; closeness; affiliation*

1 Introduction

Following the rapid progress of the economy and the digital transformation, global competition is undergoing great intensification. Therefore, the education about innovation and starting undertaking for university students has hence become one important constituent part of high-level education. [1].In the process of realizing the fast development of high education, the stressing of innovation and entrepreneurship education has become a worldwide trend. This tendency is obtaining growing importance from the country, the authority, and the community [2, 3].Innovation and entrepreneurship belong to the ability that university students use

*mengyuming975@126.com
https://doi.org/10.65102/is2026620
Published: 30 April, 2026

imaginative thinking and innovative abilities in the process of solving problems, creating value and responding to challenges, exploring opportunities and transforming them into economically or socially valuable ones [4-6]. Evaluating the innovation and entrepreneurship ability of college students and improving such ability are important issues of concern to the education sector and the society [7].Nevertheless, the current evaluation index system on the innovation and startup abilities of university students still has relatively big defects and is short of scientific strictness. Therefore, it is thus an urgent existing need to construct a scientifically correct and reasonable evaluation indicator system for the innovation and entrepreneurship abilities of university students [8, 9].

Along with the advancement of artificial intelligence, pattern recognition, which is an important sub-field of artificial intelligence, has obtained widespread concern in the design and realization of the assessment system for college students' innovation and entrepreneurship abilities. [10, 11]. Pattern recognition, i.e., a series of known, or predetermined patterns, through automatic analysis, comparison, classification, from which the essential laws and structures are extracted,through developing pattern-recognition algorithms which are based on the assessment of the innovation and entrepreneurship abilities of college students, and then applying the results of this assessment in actual real-world situations,through our effort, the comprehension of the capabilities and limitations which belong to the students can be achieved. This comprehension may be used as a reference by enterprises in the selection of latent staff members, and hence provide a basis for the government in the formulation of policies. [12-15].At the same time, the fostering and pushing forward of college students' innovation and undertaking abilities can only be more effectively pushed forward through the continuous strengthening of the evaluation system [16, 17].

Literature [18] pointed out that carrying out evaluation on college students' innovation and entrepreneurship capabilities has benefits for pushing forward the development of the innovation and entrepreneurship education framework and thus elevating the innovation and entrepreneurship skills of college students.for the purpose of making the nation become a human resource center, one evaluation method for the innovation and starting-business abilities of university students, which relies on ResNet, has been designed. Then, through the comparison of experiments, the effectiveness of this method was verified.

Literature [19] has proposed an assessment model for the innovation and entrepreneurship (I&E) thinking abilities of university students, which is built upon a neural network (NN). Through the building of an evaluation index system, this paper also put forward an evaluation flow for the innovation and entrepreneurship thinking ability of college students. Furthermore, experiments have been carried out by us to prove that this model is effective.Reference [20] has carried out the development of an evaluation model for innovation and entrepreneurship (I&E) capabilities through the utilization of a convolutional neural network. which strengthens the learning ability based on migration learning and adversarial network, and combines with game theory to avoid the problems of over-convergence and too many degrees of freedom. In literature [21], entropy-related active learning methods (ALPMs) have been proposed to study the promotion of university students' innovation and undertaking abilities. Through the compare and evaluate of the ALPCs algorithm, it was thus pointed out that the ALPCS algorithm displays outstanding performance when the quantity of queries is relatively large.

Literature [22] has brought forward a ranking promotion method which is based upon the optimal weight model. It has been manifested that under the severe employment situation, quite a lot of university graduates have the choice to start their own business undertakings, but the success rate is extremely low, indicating that the innovation and entrepreneurship ability (IEA) of university graduates is not high, and emphasizing the importance of improving the IEA and evaluating it.In the work of [23], one methodology which is used for evaluating the innovation

and entrepreneurship capabilities of college students has been developed through the utilization of the Analytic Hierarchy Process (AHP). This method has proved its effect in measuring the ability of college students in innovation and starting undertaking. This method's evaluation exactitude can attain an exceedingly lofty degree, and it uses up comparatively not much time, which effectively improves the assessment effect.Reference [24] has carried out exploration on the evaluation model of university innovation and entrepreneurship capabilities. At first this paper established evaluation indices, then this paper constructed an evaluation model by using the BP neural network, and finally this paper promoted this model through the utilization of a genetic algorithm, it has been demonstrated that the promoted algorithm in its essence is in consistency with the forecasted numerical value. It possesses a small mistake and a quick convergence speed, thus making it can be used for the assessment of innovation and entrepreneurship abilities.Reference [25] have already made an index system for innovation and entrepreneurship education ability through using the data of innovation and entrepreneurship education ability inside institutions of higher education, the entropy TOPSIS method has been utilized by us to build the model. At that time people have found that the main factors which affect the ability of innovation and entrepreneurship education contain the amount of published papers, the count of granted patents, and other similar factors.Reference [26] have completed the development of the Triangular Fuzzy Neutrophilic Number Combined Compromise Solution (TFNN-CoCoSo) method which uses as basis the Hamming distance and Euclidean distance. For the purpose of carrying out the verification of the effectiveness of the TFNN - CoCoSo method, a number of comparative experiments for decision making have been designed. This target was attained through the making of digital examples which are connected to the assessment of college students' undertaking attempts and their undertaking professional abilities.Literature [27] created an assessment model of innovation and entrepreneurship ability of college students, comprehensively analyzed the IEA of college students from various aspects such as the level of colleges and universities, students' majors, etc., and based on the one-way ANOVA analysis, analyzed the relationship between the resource inputs, the level of informatization,and other similar things, together with the International Energy Agency (IEA) under the situation of college students.The worker of Reference [28] has constructed a measurement index system for the innovation and start-up abilities of university students, and has inspected its application result, hence verifying the effectiveness of this method. which has a very high assessment accuracy rate and assessment recall rate, and has a high application value.Reference [29] puts emphasis on that it is very important to build a complete framework for nurturing the innovation and starting-business abilities of university students. This emphatic viewpoint is established upon the research data that are collected from the finance and economics institutions, carries out a deep investigation and builds an objective and detailed index system for the innovation and starting business abilities of university students. This system can provide the scientific basis which is used for carrying out the evaluation and promotion of college students' innovation and entrepreneurship abilities.The above-mentioned research carries out deep discussion on the assessment of college students' creative and starting-business abilities through utilizing methods like neural networks, hierarchy analysis, and entropy, besides that, it carries out the verification on the effect of these methods. This not only promotes the exactness and effect of the assessment but also helps higher education schools hence make counter-measures therefore improve the innovation and startup abilities of undergraduate students.

Based on the theories of fuzzy goals, fuzzy constraints and fuzzy sets, this paper proposes an evaluation model combining pattern recognition and fuzzy comprehensive evaluation method. Through summarizing the related literature on innovation and entrepreneurship ability, a "cluster of evaluation indexes" is formed. Based on the questionnaire survey, different

standardization methods and relevance tests, useless indicators are eliminated. Pattern recognition is mainly utilized to identify the sample category affiliation by using the closeness method, to stratify the indicator system and classify the indicators, and to establish a suitable evaluation indicator system. With the fuzzy comprehensive judgment method,after that, the evaluation results of innovation and entrepreneurship abilities can be acquired. In this research article, by selecting the college students of X institution as the survey object sample for empirical analysis, the rationality and practical feasibility of the fuzzy comprehensive evaluation model based on pattern recognition are finally proved.

2 Principles of fuzzy pattern recognition

Along with the high-standard development that China's digital economy is going through, the combination of digital technology and education in the fields of innovation and entrepreneurship has already become a new tendency.Academics summarize entrepreneurial ability as a comprehensive ability with practicality and creativity that entrepreneurs show in the process of discovering new fields, identifying entrepreneurial opportunities, generating unique insights into the creation of new things, and being able to develop and create new things by using a variety of methods and means in the process of their activities. This ability can transform their own knowledge and skills into real productivity, so as to realize their own value. Academics summarize the entrepreneurial ability of postgraduates as the sum of knowledge and skills formed in the process of discovering and timely identifying entrepreneurial opportunities, integrating resources in the process of entrepreneurship, and creating new economic and social value, as demonstrated by postgraduates in the process of entrepreneurial activities with school registration [30].

2.1 Fuzzy goals and fuzzy constraints

Usually, objectives are given in various abstract ways. For example: "to make the factory better", "to improve the service attitude to satisfy the customers". In this case, the evaluation criteria are mostly determined by the decision maker. In relation to this, there should be an evaluation function - in essence, an affiliation function - to represent it. The evaluation function can be used to measure the extent to which the objective is achieved by selecting an unquestioned strategy from the set of strategies.

Using the evaluation function facilitates us to select the best solution.

As a constraint on the selection of the program, there are two kinds of constraints: one is never allowed to be ambiguous, strict constraints, such as "absolutely not allowed to exceed one hundred dollars": the other is a "soft" constraint, which is a kind of leeway, ambiguous language fuzzy constraints, such as in the For example, when choosing housing, we should attach the condition of "convenient transportation, easy to commute", which is a fuzzy constraint. In real life, most of the decisions have fuzzy and ambiguous constraints. For a set of strategies, unambiguous and clear constraints specify a classical subset, while fuzzy or soft constraints correspond to a fuzzy subset.

The simplest decisions have clear objectives. The set of strategies at this point can be divided into two subsets, those that can reach the goal and those that cannot reach or goal, and the boundaries are clear, so they are classical subsets. At this point, the intersection of the subset that can reach the goal and the subset that can satisfy the constraints is the optimal strategy Chai. This idea and method can also be generalized to the decision making with fuzzy goals li fuzzy constraints [31].

Let the strategy set be X:

$$X = \{x\} \tag{1}$$

Then let the set of strategies that satisfy the fuzzy objective be G and the set of strategies that satisfy the fuzzy constraints be C. Both G and C are fuzzy subsets of X. The set of strategies that satisfy the fuzzy objective is G. At this point, the desirable ideal strategy D is:

$$D = G \bigcap C \tag{2}$$

In the case of multiple objectives and multiple constraints, $G_2, G_2, ..., G_n$ as fuzzy goals, $C_1, C_2, ..., C_m$ are fuzzy constraints, then there are:

$$D = G_1 \cap G_2 \cap ... \cap G_n \cap C_1 \cap C_2 \cap ... \cap C_m \tag{3}$$

From the above definitions, it is clear that objectives and constraints, for decision making, play essentially the same role.

The set of ideal strategies for which the affiliation function A_D is maximal is called the maximization decision, denoted D^M :

$$D^M = \{x_0 \in X \mid A_D(x_0) \to \max(A_D(x))\} \tag{4}$$

The above fuzzy goals and fuzzy constraints are treated as fuzzy subsets on the set X of strategies. However, more rigorously, fuzzy goals should be viewed as fuzzy subsets on the set T = {y} of outcomes of policy implementation. Thus, the mapping f of strategies and outcomes is:

$$f : X \to T \tag{5}$$

Here, $x \in X$ and $f(x) \in T$.

When we consider the affiliation function of x to the target G, we are actually considering the affiliation function of $f(x)$ to G.

Eq. can also be expressed as an operation on the affiliation function:

$$\begin{aligned} A_D(x) &= A_{G_1}[f(x)] \wedge A_{G_2}[f(x)] \wedge ... \\ &\wedge A_{Gn}[f(x)] \wedge A_{C_1}[f(x)] \wedge A_{C2}[f(x)] \wedge ... \\ &\wedge A_{Cm}[f(x)] \end{aligned} \tag{6}$$

2.2 Pattern Recognition and Fuzzification

2.2.1 Concept of fuzzy sets

Based on the classical set theory, for an object a, it either becomes a member of set A or does not become a member of set A, hence there do not exist any other membership relationships. In modern science and engineering use cases, the concept of fuzzy set often comes forth. This viewpoint puts forward that object a has a certain degree of belonging to set A, and this thought is the foundation of fuzzy sets [32].

Fuzzy logic has obtained widespread utilization in many different fields, which contain science, engineering, agriculture, and medicine. In the real actual world, the depiction of objects

cannot always reach the topmost grade of accuracy. Professor Zadeh puts emphasis that "along with the increment of a problem's complexity, precise descriptions will lose their meaning and meaningful descriptions will lose their precision."

2.2.2 Affinity Functions and Fuzzification

An exact data is fuzzified by means of an affiliation function, and the commonly used affiliation functions at present mainly include: triangular affiliation function, In these are included the bell-shaped membership function, the Gaussian membership function, the Sigmoid-type membership function, and other similar ones [33].

In this thesis paper, the Gaussian membership function is mainly utilized by us to carry out the fuzzification work for the index data. This selection is because of the function's characteristics such as continuous property, symmetric property, and analytical easy handling property. The mathematics expression of the Gaussian membership function is just like below:

$$f(x) = e^{-\frac{(x-c)^2}{2\sigma^2}} \tag{7}$$

The shape of the Gaussian affiliation function with different c and σ parameters is consistent with the shape of the normally distributed probability density function. It can be deduced from its analytical formula that when c changes, the curve of the affiliation function becomes wider and the shape remains unchanged, and it only makes left and right translation, while when σ changes, the curve becomes wider or narrower, and the horizontal position remains unchanged. Therefore, when fuzzifying the index data, the parameters of σ and c can be changed according to the actual situation or requirements, so that when the data are fuzzified, the degree of affiliation to different fuzzy sets (intervals) changes accordingly.

2.2.3 Pattern recognition of the indicator system

The discrimination of patterns mainly includes the layering of the indicator system and the level classification of indicators [34].

Stratification refers to the division according to layers of the index system. This system is divided into three layers: the first layer A, the second layer B, and the third layer C.

The layered classification of the indicator includes dividing the real data of the indicator into N sections according to the value range. Every one of these intervals is then expressed by a membership function through a symbolic method, furthermore, one group of membership functions can make unclear the data that got from a precise real-world experiment or investigation, therefore making it to become fuzzy data.When the value scope of real-world data is cut into three sections, this shows the data is belonging to three fuzzy sets. These blurry collections can be described by means of three subordinate functions. Under usual circumstances, their corresponding explanations in physics are "low", "moderate", and "high".In this study work, the real world data are divided into four fuzzy sets. These collections are expressed via four belonging functions, and their corresponding physical explanations are "excellent", "satisfactory", "moderate", and "below standard".

3 Fuzzy integrated evaluation based on pattern recognition

For the purpose of fuzzy set evaluation of comprehensive innovation and entrepreneurship capabilities, the multi-layer system can be divided into comprehensive unit system and basic unit system. The following is a hybrid method for fuzzy set evaluation of comprehensive

innovation and entrepreneurship capabilities that is further proposed in this section based on this principle.

The basic unit system means that the input factors of the unit system are a number of basic indicators, and each basic indicator has a multi-level evaluation standard value, which is further evaluated. The evaluation is carried out with the corresponding level of criteria of each basic indicator, and the output is the relative affiliation value of the corresponding level. Comprehensive unit system refers to the unit system that consists of a number of basic unit system outputs and the corresponding input factors of the system.

In this paper, we believe that for these two kinds of unit systems, the fuzzy comprehensive evaluation of comprehensive innovation and entrepreneurship ability should take the same fuzzy comprehensive judgment model, i.e., the basic unit system based on the evaluation of fuzzy pattern recognition model.

If there exist t mutually juxtaposed unit systems at the same level, the evaluation results of this basic unit system form the input factor set of a certain comprehensive unit system. Then the output of l basic unit systems can be further calculated:

$$u_l = (u_{1l}, u_{2l}, \cdots, u_{hl}, \cdots, u_d) \tag{8}$$

Let $v_{lh} = u_{hl}, l = 1, 2, \cdots, t; h = 1, 2, \cdots, c$.

So the set of input factors to the integrated unitary system is a matrix of $t \times c$:

$$V_{rsc} = \begin{bmatrix} v_{11} & v_{12} & \cdots & v_{1e} \\ v_{21} & v_{22} & \cdots & v_{2e} \\ \vdots & \vdots & \ddots & \vdots \\ v_{d1} & v_{d2} & \cdots & v_{de} \end{bmatrix} = (v_{ih}) \tag{9}$$

Further use of the fuzzy composite judgment model results in the evaluation of this integrated unit system, i.e., a vector of relative affiliations for each hazard class:

$$B = (b_1, b_2, \cdots, b_c) = (w_1, w_2, \cdots, w_t) \circ \begin{bmatrix} v_{11} & v_{12} & \cdots & v_{1c} \\ v_{21} & v_{22} & \cdots & v_{2c} \\ \cdots & \cdots & \cdots & \cdots \\ v_{t1} & v_{t2} & \cdots & v_{tc} \end{bmatrix} \tag{10}$$

where "$\circ$" refers to the composite operator.

4 Design of the evaluation system for innovation and entrepreneurship and assignment of weights

4.1 Construction of Indicators for Measuring Innovation and Entrepreneurship Ability

By summarizing the existing research results and literature, a "cluster of assessment indicators" was initially formed. Then, 10 industry experts in innovation and entrepreneurship guidance were invited to score the indicators in the cluster, and the results are shown in Table 1. In the scoring table, the points of each item are calculated as the sum of the values of "general" +

“unimportant” + “least important”. Therefore, the integral values below 4.5 will be directly retained, while those with integral greater than 10 will be directly excluded.Besides that, ten professional experts brought in the indexes that have connection with the innovation and starting undertaking abilities of university students in teacher cultivation organizations to ensure the reasonability of this study. As a result, we can get the “Alternative Pool of Indicators for Measuring the Innovation and Entrepreneurship Ability of College Students in Teachers' Colleges”. It should be pointed out that the options retained in the current pool need to be rigorously and scientifically tested. After the establishment of the element pool, this study combines the theoretical results of the existing research to form the upper index of the index system.

Table 1: Expert rating

Program	Very important	Important	General	No important	No very important	Total
Opportunity recognition	2	3	4	1	0	10
Opportunity assessment capability	1	4	5	1	0	11
Resource ability	2	3	3	2	0	10
Resource requirements analysis ability	1	4	5	1	0	11
Team building ability	1	4	6	2	0	13
Team operational ability	2	3	4	0	0	9
Risk identification	3	3	3	1	1	11
Risk resistance	3	4	6	1	0	14
Technical ability	1	5	4	2	1	13
Interpersonal skills	2	3	3	0	0	8
Financing capacity	4	3	5	1	0	13
Technical learning ability	2	4	4	0	0	10
Innovation consciousness	2	4	4	1	0	11
Self-adjustment	6	3	5	2	0	16
Confidence	2	3	3	2	0	10
Integrity	5	4	3	1	0	13
Tenacity	2	4	4	0	0	10
Responsibility	3	5	5	1	1	15
Dare to question	1	4	5	2	0	12
Optimism	2	5	4	1	0	12

4.2 Questionnaire development and calculation of indicator weights

We take "one undergraduate student coming from a common university" as our illustration. A investigation concerning innovation and starting undertaking abilities has been conducted by means of the Likert five-point grading scale method, and each statement had five responses: "very consistent", "somewhat consistent", "average", "not compliant" and "very unsatisfactory", and the scores were recorded as 5, 4, 3, 2 and 1 respectively. The main distribution vehicle of the questionnaire is the electronic questionnaire carried by WeChat applet, and the main distribution target is the entrepreneurial students in the maker space of a teacher's college and the students who participate in various competitions of innovation and entrepreneurship of college students, with a total of 120 pieces of data.

In this study, the reliability of the elements which are used to assess the innovation and entrepreneurship ability of one organization was obtained through analyzing the questionnaire data by SPSS, which is shown in Table 2, and the Cronbach's α values in this study were all above 0.815 and the CITC coefficients were all greater than 0.5. Considering that the item “I tend to like to put forward opposing views” item did not have a high CITC value, this item was deleted.

Table 2: Reliability test results

Inspection dimension	Inspection item	CITC value	The cronbachbar s α value after deleting	Cronbachales α
Risk taking	Opportunity recognition	0.678	0.863	0.815
	Opportunity assessment capability	0.722	0.784	
	Resource ability	0.801	0.822	
Organizational management	Resource requirements analysis ability	0.724	0.812	0.850
	Team building ability	0.763	0.796	
	Team operational ability	0.742	0.836	
Resource integration	Risk identification	0.722	0.874	0.833
	Risk resistance	0.701	0.786	
	Technical ability	0.723	0.795	
Innovative ability	Interpersonal skills	0.663	0.733	0.874
	Financing capacity	0.710	0.825	
	Technical learning ability	0.781	0.894	
Professionalism	Innovation consciousness	0.689	0.814	0.824
	Self-adjustment	0.724	0.863	
	Confidence	0.615	0.714	
	Integrity	0.714	0.822	
	Tenacity	0.221	0.847	
	Responsibility	0.613	0.820	

For different types of innovation and entrepreneurship capacity assessment indicators, different standardization methods are applied. For quantitative type indicator data, the standardized scores are calculated one by one according to the characteristics of the indicator data, and the results are shown in Table 3.

Table 3: Standardization of index data

Standardized score				
Order	Criterion layer	Index	Borrower 1~1000	
1	Seize the opportunity	Opportunity recognition	1.00	1.00
2		Opportunity assessment capability	0.42	0.42
3		Opportunity usage	1.00	1.00
4	Risk taking	Risk identification	0.56	0.64
5		Risk resistance	0.64	0.64
6		self-adjustment	0.59	0.63
7	Organizational management	Interpersonal skills	0.63	0.43
8		Team building ability	0.02	0.42
9		Team operational ability	0.22	0.22
10	Resource integration	Resource requirements analysis ability	1.00	1.00
11		Resource assessment capability	0.64	0.44
12		Resource ability	1.00	1.00
13	Innovative ability	Innovation consciousness	1.00	1.00
14		Technical learning ability	0.82	0.82
15		Technical ability	0.46	0.76
16	Professionalism	Confidence	0.46	0.66
17		Integrity	0.36	0.42
18		Ttenacity	0.38	0.44
19		Responsibility	0.12	0.42
20		Optimism	0.42	0.42

We use the standardized sample data which were got in the foregoing section to calculate the correlation coefficient between the 20 innovation and entrepreneurship assessment indicators. The coefficient of correlation is shown within Figure 1.

After we compare the correlation coefficients between the innovation and entrepreneurship evaluation indicators which are shown in the graph, we can deduce that the absolute size of the correlation coefficients between the selected innovation and entrepreneurship evaluation indicators does not go beyond 0.8, so the selected assessment indicators don't need to be excluded.

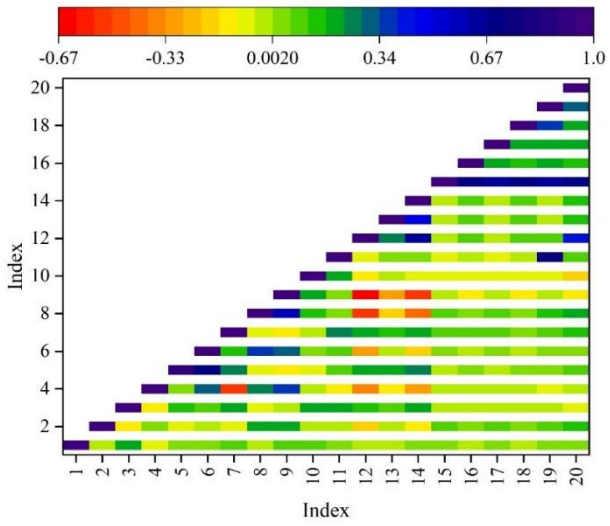

Figure 1: Evaluation index correlation test

All the rows with exactly the same value in each row of the sample categorization matrix type are grouped into one category. By categorizing all rows of all categorization matrices, thus obtaining all samples of innovative entrepreneurial ability category attribution. The classification of the samples in each category is shown in Figure 2, and the categorization matrix of the four categories obtained: very good, excellent, fair, and poor. The significance of the sample categorization will be tested in combination with the F-test: here the significance level $\alpha=0.05$ is taken, and the F-statistic is calculated:$F=17.32>F0.05=1.98$. From this, we can get:The sample categorization is significant and has a good categorization effect.

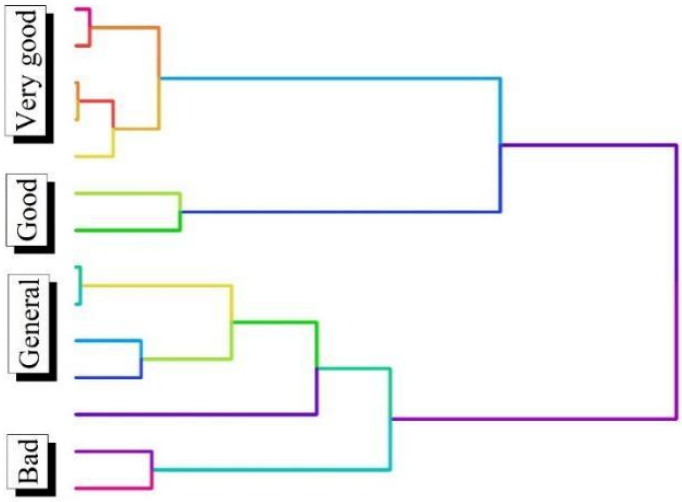

Figure 2: Fuzzy clustering results

4.3 Assignment of weights

The Super Decision software scores and processes the expert scores to obtain the consistency-tested supermatrix W, the weighted supermatrix W, and the limit-weighted supermatrix L. Any non-zero column element of the limit-weighted supermatrix is the weight of each criterion. At the same time, the Super Decision software can derive more intuitive weighting results as shown in Table 4. From the table, it can be seen that the weights of the abilities of grasping opportunities, risk taking, organizational management, resource integration, innovation ability, and professionalism are 0.14, 0.10, 0.15, 0.19, 0.20, and 0.24, respectively.

Table 4: index weight

Primary indicator	Weighting	Secondary indicator	Weighting
Seize the opportunity X1	0.14	Opportunity recognition X11	0.36
		Opportunity assessment capability X12	0.37
		Opportunity usage X13	0.27
Risk taking X2	0.10	Risk identification X21	0.31
		Risk resistance X22	0.34
		self-adjustment X23	0.35
Organizational management X3	0.15	Interpersonal skills X31	0.35
		Team building ability X32	0.34
		Team operational ability X33	0.31
Resource integration X4	0.19	Resource requirements analysis ability X41	0.37
		Resource assessment capability X42	0.31
		Resource ability X43	0.32
Innovative ability X5	0.20	Innovation consciousness X51	0.30
		Technical learning ability X52	0.30
		Technical ability X53	0.40
Professionalism X6	0.24	Confidence X61	0.16
		Integrity X62	0.21
		Ttenacity X63	0.24
		Responsibility X64	0.20
		Optimism X65	0.19

5 Application exploration

5.1 Sample Selection and Data Sources

This experiment was conducted with college students enrolled in X University, using stratified sampling method, involving different genders, grades, subject categories, individual characteristics and so on.In this research work, a great total of 470 electronic questionnaires were collected through the WeChat app, and after excluding invalid questionnaires, the number of valid questionnaires was 430, with an effective rate of 91.49%.

(1) Basic information

Table 5 shows the basic information of investigated people from 430 effective questionnaire forms. Because the tested objects of this experiment are the undergraduate students who are registered at teacher cultivation organizations,it is limited by the characteristics of the teacher training colleges themselves, which leads to the inconsistency of the proportion of men and women, and is mainly dominated by female students, the proportion of which can be identified with about 3:7. in the distribution of grades, it can be seen that the students of the survey are mainly concentrated in the junior and senior grades, but there is still a some freshman and sophomore students, of which the freshman students are negligible. In terms of specialty categories, it can be seen that mainly students of teacher training majors are dominated, and their ratio can be identified as about 7:3. 96.82% of all surveyed students have received innovation and entrepreneurship education, which means that the innovation and entrepreneurship education of University X has been fully implemented on campus.

(2) Information on innovation and entrepreneurship learning

In the 430 valid questionnaires, the information got from survey participants is related to the investigation of innovation and entrepreneurship courses, 69.57% of the students have studied more than 3 courses about innovation and entrepreneurship education, among them 16.33% have studied more than 5 courses about innovation and entrepreneurship education, and

16.39% of the students said that they are not sure about the number of courses they have received. In the project of "active participation in organizations or activities related to innovation and entrepreneurship", 77.23% of the students participated in the organizations or activities related to innovation and entrepreneurship to a greater or lesser extent, among them, the students who participated in the lectures on innovation and entrepreneurship were relatively more,however, 22.77% of the students have said that they never on their own initiative took part in the organizations or activities that are connected with innovation and entrepreneurship.

(3) Particulars concerning the present situation of innovation and commercial starting undertaking attempts

There are 24.71 % of students who have no intention to carry out innovative and entrepreneurial activities. It is noteworthy that 53.20% of the students have the will or idea to carry out innovation and entrepreneurship activities. Among the 22.09% of students who have carried out actual behavioral activities,nevertheless, 7.7 percent among them still steadfastly carry on the pursuit of innovation and pioneering undertaking works, which means that some of them still insist on it and aspire to realize their own value through innovation and entrepreneurship activities.

Table 5: The basic information table for the object

Project	Categories	Percentage
Gender	Man	32.58%
	Female	67.42%
Grade	Freshman year	0.78%
	Sophomore	6.83%
	Junior	62.38%
	Senior year	30.01%
Whether it belongs to the normal	Normal major	72.94%
	Non-normal major	27.06
Is it innovative entrepreneurship education	Yes	96.82%
	No	3.18%
The number of innovative entrepreneurship education courses accepted	Above 5	16.33%
	3-5	53.24%
	Following three	14.03
	Inclarity	16.4%
Active participation in innovative entrepreneurship or activities	Creative entrepreneurship lecture	25.2%
	Innovative entrepreneurship contests	23.47%
	Innovative entrepreneurship organizations	18.62%
	Other	9.94%
	Unparticipated	22.77%
Innovation and entrepreneurship experience	Don't want to innovate	24.71%
	The idea, but no real action	53.20%
	There was a real action, but no persistence	14.32%
	Still insist on starting a business, or starting a business	7.77%

5.2 Measurement results

It is well known that the cultivation method of X college is obviously different from other colleges and universities, and there is no further consideration of this in the above obtained innovation and entrepreneurship ability measurement system, therefore, this chapter hopes to discuss the data collected from the innovation and entrepreneurship ability evaluation system according to the differences in the selection of the different options by means of further

empirical analyses, i.e., in the ensuing analysis of the data, we will mainly focus on the individual options of the statistical results to start the description and analysis.

The results of the analysis are shown in Figure 3, according to the calculated weights of the secondary indicators [0.36, 0.37, 0.27], we can get the overall score of grasping opportunities: 2.4256, and the overall situation is relatively weak.

The overall score of risk taking is: 2.8582, the overall situation is just qualified.

According to the weights of the secondary indicators [0.35, 0.34, 0.31], we can get the overall score of organization management: 3.2630, which is relatively strong.

According to the weights of the secondary indicators of resource integration [0.37, 0.31, 0.32], the overall score of resource integration is 3.3616.

The overall score of innovation ability is: 2.7082, and the overall situation is just qualified.

The overall score of professionalism is 3.1388, and the evaluation result is relatively strong professionalism.

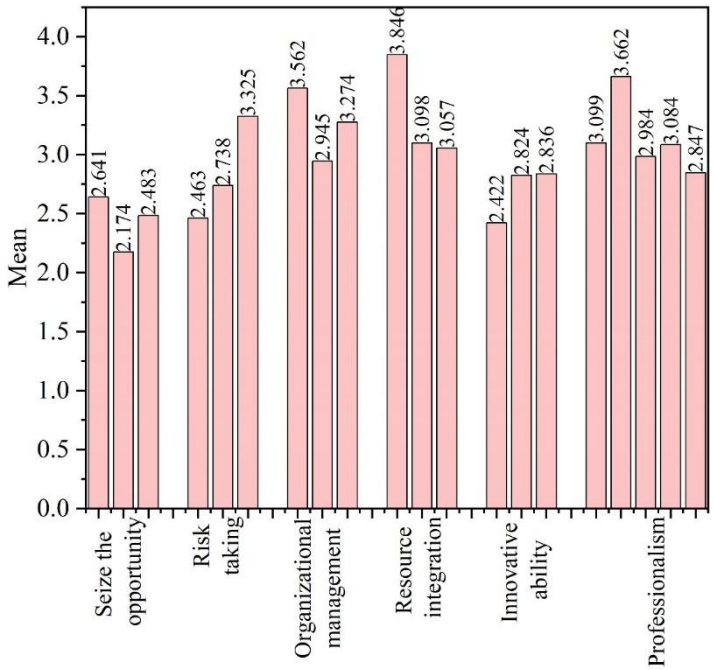

Figure 3: Differential analysis

The students' performance in each innovation and entrepreneurship factor is evaluated as shown in Figure 4. For example, in terms of "opportunity identification ability", the reviewers rated 35% of students as "very good", 34% as "good", 21% as "fair", and 11% as "poor". Then, based on the first-level index weights and the fuzzy comprehensive evaluation matrix, the second-level fuzzy transformation and normalization were obtained,to speak specifically, around 35 percent of those students have shown "excellent" innovation and starting business abilities. Another additional near 35 percentage of the students possessed "praiseworthy" innovation and undertaking abilities. At the same time, the proportion of students whose innovation and enterprise abilities got the "ordinary" evaluation is lower than 20%,in addition, 10 percent of the students have shown "weak" innovation and starting business abilities. To make a conclusion, nearly 70 percent of the students have displayed outstanding performance on innovation and entrepreneurship.this shows that the college has reached specific results in the cultivation of students' innovation and entrepreneurship abilities. Nevertheless, in entrepreneurial practice and collaborative team work, there is still space that can be further promoted.

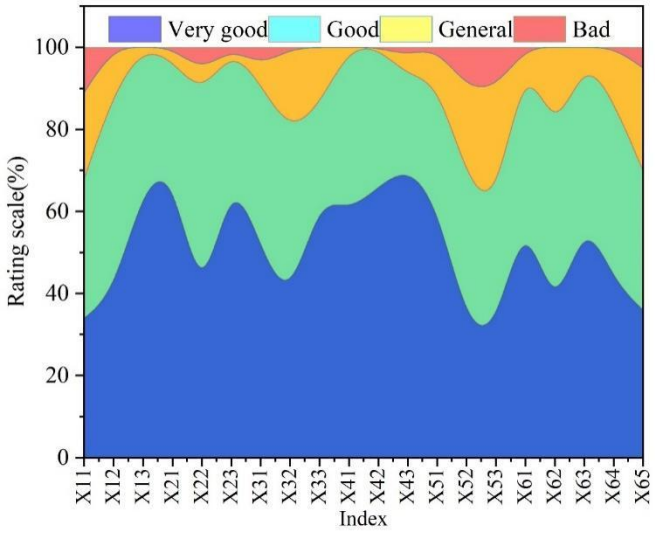

Figure 4: Evaluation result

6 Conclusion

In this paper, in the evaluation process of innovation and entrepreneurship ability of college students, the pattern recognition method is used to identify the sample data, and the indicator level is reasonably divided into the categories with the greatest degree of closeness, so that the category division effect is more reasonable and scientific. Then the fuzzy evaluation method is used to determine the weights of these evaluation indicators. Through comprehensive consideration and combining the two methods, the evaluation of innovation and entrepreneurship ability is studied in depth. The empirical study shows that

The result values of the weight coefficients of the evaluation indexes for innovation and entrepreneurship abilities are given in visual form through Super Decision software. The order of ranking is arranged like this:risk-taking < grasping opportunities < organizational management < resource integration < innovation ability < professionalism. In the evaluation results of innovation and entrepreneurship ability of college students in X college, the overall scores of opportunity-seizing, risk-taking and innovation ability do not exceed 3 points, and the overall situation is just qualified. However, the overall scores of resource integration, organizational management, innovation ability and professionalism are more than 3, and the overall situation is relatively strong.

References

[1] Udaltsova, N. L. (2020). Digital Transformation of Economy. Quality-access to success, 21(175).

[2] Silesky-Gonzalez, E., Lezcano-Calderon, Y., & Mora-Cruz, A. (2025). Effects of education for entrepreneurship and entrepreneurial intention in university students. International Entrepreneurship and Management Journal, 21(1), 1-22.

[3] Li, F. (2018). Quality Evaluation Method of College Graduates' Innovation and Entrepreneurship Education Based on the Principle of Brain Neurology. Educational Sciences: Theory & Practice, 18(6).

[4] Zhang, X., & Li, W. (2025). University Innovation and Entrepreneurship Education. Neutrosophic Sets and Systems, 355.

[5] Li, P., Gong, L., Miao, Y., Zhao, Y., Li, A., & Ren, H. (2023). Higher Vocational Students' Innovation and Entrepreneurship Ability Demand Prediction. International Journal of Emerging Technologies in Learning, 18(8).

[6] Haigen, Y., & Xiao, F. (2016, December). Research on innovation and entrepreneurship education for college students of electronic and information majors. In 2016 8th international conference on information technology in medicine and education (ITME) (pp. 701-704). IEEE.

[7] Keelson, S. A., Addo, J. O., Kwarteng, K., & Amoah, J. (2025). The Role of Innovation in Fostering Entrepreneurial Mindset among TVET Students. African journal of applied research, 11(1), 285-305.

[8] Chen, Q. (2025). Evaluation method of service quality of college students' innovation and entrepreneurship education based on AHP-DEA method. International Journal of Innovation and Sustainable Development, 19(1), 26-42.

[9] Sun, X., & Zhang, Y. (2022). An improved BP neural network algorithm for the evaluation system of innovation and entrepreneurship education in colleges and universities. Mobile Information Systems, 2022(1), 1007538.

[10] He, M., & Zhang, J. (2023). Evaluating the innovation and entrepreneurship education in colleges using BP neural network. Soft Computing, 27(19), 14361-14377.

[11] Zhang, J., Williams, S. O., & Wang, H. (2018). Intelligent computing system based on pattern recognition and data mining algorithms. Sustainable Computing: Informatics and Systems, 20, 192-202.

[12] Fu, K. S. (2019). Syntactic pattern recognition. In Applications of Pattern Recognition (pp. 37-64). CRC Press.

[13] Zhang, X. Y., Liu, C. L., & Suen, C. Y. (2020). Towards robust pattern recognition: A review. Proceedings of the IEEE, 108(6), 894-922.

[14] Zhao, L., Li, H., & Chen, L. (2022). Factors influencing Chinese college students' innovation and entrepreneurship ability: The moderating effect test based on entrepreneurial atmosphere. Sustainability, 14(20), 13020.

[15] Luo, Y., & Yang, H. (2025, May). Construction of Evaluation Model for College Students' Innovation and Entrepreneurship Ability Under the Background of Digital. In Advances in Computational Vision and Robotics: Proceedings of the International Conference on Computational Vision and Robotics-ICCVR-2024 (Vol. 47, p. 311). Springer Nature.

[16] Li, C., & Sun, Z. (2024). Evaluation of the Quality of Sustainable Entrepreneurship Education in Universities Based on the Grey Correlation Algorithm. Journal of Information & Knowledge Management, 23(03), 2450026.

[17] Di, H., & Li, P. (2023). Comprehensive evaluation of innovation and entrepreneurship

ability in the context of sustainable development. International Journal of Sustainable Development, 26(3-4), 291-305.

[18] Wang, F., & Ying, Y. (2022). Evaluation of students' innovation and entrepreneurship ability based on ResNet network. Mobile Information Systems, 2022(1), 7772415.

[19] Zhang, F., & Xi, L. (2021). An evaluation model for the innovation and entrepreneurship thinking ability of college students based on neural network. International Journal of Emerging Technologies in Learning (iJET), 16(2), 188-204.

[20] Zheng, Y. (2024). A transfer learning-based model for assessing university students' innovation and entrepreneurship. International Journal of Computational Systems Engineering, 8(1-2), 66-74.

[21] Chen, S. (2022). Analysis of College Students' Ability to Improve Innovation and Entrepreneurship Based on Constrained Clustering Algorithm. Wireless Communications & Mobile Computing (Online), 2022.

[22] Guo, W., Liu, L., Yao, Y., & Shen, T. (2022). Refinement method of evaluation and ranking of innovation and entrepreneurship ability of colleges and universities based on optimal weight model. Discrete Dynamics in Nature and Society, 2022(1), 1910528.

[23] Liu, W. (2022). An evaluation method of college students' innovation and entrepreneurship ability based on AHP method. International Journal of Environment and Pollution, 71(1-2), 25-36.

[24] Li, S. (2022). Evaluation model of innovation and entrepreneurship ability of colleges and universities based on improved BP neural network. Computational Intelligence and Neuroscience, 2022(1), 8272445.

[25] Quan, L., & Zhou, H. (2018). Evaluation of innovation and entrepreneurship education capability in colleges and universities based on entropy TOPSIS-a case study. Educational Sciences-Theory & Practice, 18(5).

[26] Zhou, J. (2023). A novel method for solving "Entrepreneurship and Entrepreneurship" career ability evaluation of local college students with triangular neutrosophic numbers. Journal of Intelligent & Fuzzy Systems, 45(6), 11233-11246.

[27] Qi, Y., Liang, T., & Chang, Y. (2021). Evaluation of College Students' Innovation and Entrepreneurial Ability for the Science and Technology Service Industry. International Journal of Emerging Technologies in Learning (iJET), 16(5), 228-247.

[28] Ruan, C., & Ruan, Y. (2023). Study on construction and application effect of the evaluation index system of college students' innovation and entrepreneurship ability. International Journal of Sustainable Development, 26(3-4), 226-242.

[29] Tian, Y., & Wang, Q. (2024). Construction of Index System for College Students' Innovation and Entrepreneurship Ability: Evidence from Finance and Economics Colleges. Asia Pacific Economic and Management Review, 1(6), 1-7.

[30] Changjiang Xu. (2024) .Construction and Implementation of Innovation and

Entrepreneurship Education System in Higher Vocational Colleges in the New Era Based on VAR Modeling. Applied Mathematics and Nonlinear Sciences,9(1).

[31] Nima Kazemi,Ehsan Ehsani & Christoph H. Glock. (2014) .Multi-objective supplier selection and order allocation under quantity discounts with fuzzy goals and fuzzy constraints. Int. J. of Applied Decision Sciences,7(1),66-96.

[32] Prem Kumar Singh. (2017) .Complex vague set based concept lattice. Chaos, Solitons and Fractals: the interdisciplinary journal of Nonlinear Science, and Nonequilibrium and Complex Phenomena,96,145-153.

[33] Mingrui Fu,Shuai Chen,Xiaoxiao Wei,Jinsong Du,Wei Wang & Jinhai Liu. (2025) .A Simplified Adaptive Fuzzy Min–Max Neural Network for pattern classification. Neurocomputing, 630,129668-129668.

[34] Liuwei Zhang,Yanlei Hu,Jianglei Zhang,Ming Cai,Lili Lan & Guoxiang Sun. (2025) .Application of chemical pattern recognition and similarity evaluation in electrochemical and HPLC-DAD fingerprints for quality consistency study of herbal medicines. Analytica Chimica Acta,1349,343830-343830.