Journal of Contemporary Educational Research, 2025, Volume 9, Issue 8
http://ojs.bbwpublisher.com/index.php/JCER
ISSN Online: 2208-8474
ISSN Print: 2208-8466

Research on the Construction of an Evaluation System for Innovation and Entrepreneurship Capabilities of Normal University Students Based on Factor Analysis Method

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Abstract: Under the National Innovation-Driven Development Strategy, establishing a scientifically sound evaluation system for normal university students' innovation and entrepreneurship capabilities serves as a crucial foundation for optimizing innovation education models and enhancing teacher candidates' comprehensive competencies. Based on existing indicator frameworks, we designed a questionnaire and applied exploratory factor analysis (EFA) to screen indicators, reduce dimensionality, and analyze weighting. This process identified key metrics for evaluating pedagogical students' innovation capacities, ultimately constructing a targeted assessment system for normal university students. The study provides theoretical support for cultivating teacher trainees' innovative capabilities while contributing to the national innovation strategy implementation

Keywords: Factor analysis; Innovation and entrepreneurship capability; Indicator system; Evaluation system; Universities; Normal university students

Online publication: 17th September 2025

1. Introduction

Normal universities, as training bases for future educators, directly influence societal innovation capabilities and the advancement of the education industry through the quality of their innovation and entrepreneurship education. Currently, such education for normal university students still faces challenges such as outdated curriculum systems, insufficient practical platforms, and a shortage of qualified faculty. How to clarify educational objectives and implementation pathways, promote the deep integration of mass entrepreneurship and innovation (dual-creation) education with teacher education, and enhance the relevance and effectiveness of teaching content remains an urgent problem to be solved [1]. Researchers widely agree that establishing a scientific and rational evaluation system is crucial for improving normal students' innovation and

entrepreneurship capabilities. Yao constructed an evaluation system for the effectiveness of entrepreneurship education in normal universities, comprising 17 subjective and objective indicators, based on the Theory of Planned Behavior (TPB) and the Analytic Hierarchy Process (AHP) [2]. Feng, under the background of smart education, used AHP to build an evaluation index system for normal university students' innovation capability and validated its rationality through reliability and validity analysis [3]. Yang employed factor analysis to test the quality assessment system for innovation and entrepreneurship education [4]. Factor analysis offers significant advantages in constructing evaluation systems, as it can effectively extract common factors, thereby enhancing the scientificity and systematicity of evaluation indicators. This study synthesizes previous research findings to select 18 indicators. A questionnaire survey was designed based on the current state of normal university students' innovation and entrepreneurship capabilities. The aim is to employ factor analysis to derive a tailored evaluation system for normal students' innovation and entrepreneurship capabilities. Based on the survey results and the factor analysis findings, the study seeks to provide theoretical support for the development of innovation and entrepreneurship capabilities within normal universities and contribute to the national cultivation of innovative and entrepreneurial talents.

2. Preliminary construction of the evaluation system

The construction of the evaluation system of College Students' innovation and entrepreneurship ability needs to integrate multi-dimensional factors Zhang proposed that core competencies for innovation and entrepreneurship encompass dimensions such as value orientation and personality traits [5]. Ren highlighted implicit qualities like "learning ability" within general competencies [6]. He explicitly listed "entrepreneurial knowledge" as an evaluation element [7]. Sun further refined this into a combination of "entrepreneurial knowledge" and "entrepreneurial skills" [8]. Practical engagement level was frequently emphasized in the research of Wang [9] and Yuan [10]. The required capabilities for innovation and entrepreneurship encompass composite elements such as "opportunity identification ability" and "resource integration ability" mentioned by Lai [11], as well as "innovative thinking" and "practical ability" discussed by Duan [12]. Through an extensive review of literature, combined with observations of university students' real-world performance, and supplemented by field visits and surveys, an evaluation system encompasses self-awareness, professional knowledge, practical engagement level and the required capabilities for innovation and entrepreneurship.

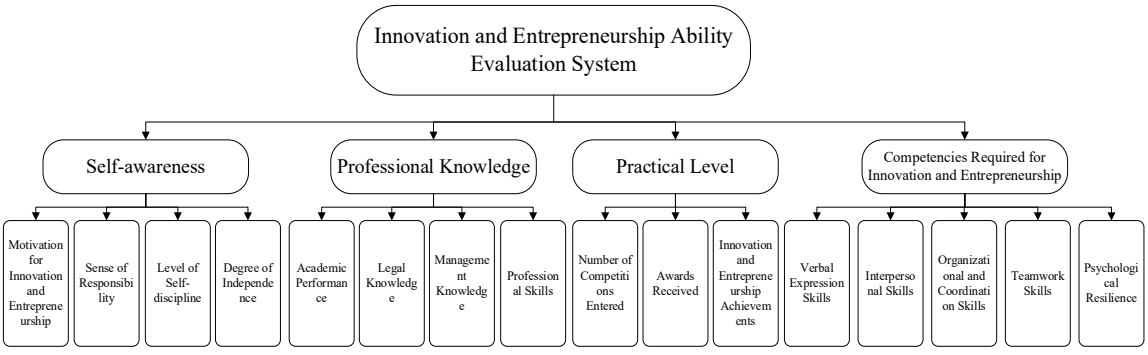

Figure 1. Preliminary construction of an innovation and entrepreneurship capability evaluation system.

3. Research methodology

3.1 Research approach

Questionnaires were employed to collect student-related information mapped in conceptual diagrams, followed by screening valid responses for collation and summarization. Factor analysis was applied to identify key determinants of innovation and entrepreneurship capabilities, establishing an evaluation framework.

3.2. Research methods

3.2.1. Data preprocessing

Given that the indicators have different dimensions [13], the raw data were standardized to eliminate dimensional influences. The formula is as follows:

$$Z_i = \frac{X_i - X_{min}}{X_{max} - X_{min}} \quad (1)$$

In the formula, X_i represents the original data, and Z_i represents the standardized data.

3.2.2. Adaptability analysis

Conduct KMO and Bartlett's sphericity tests on the variables, and judge the Sig value and KMO value. Use SPSS to process the standardized data to obtain the characteristic values and variance contribution rates of each factor. The higher the variance contribution rate of the common factor, the greater its impact on the result [14]. Use the maximum variance method for factor rotation [15], calculate the factor score coefficient matrix, and obtain the expression of the common factor.

$$Y = \sum_{i=1}^{n} \frac{e_i}{E} Y_i \quad (2)$$

In the formula, Y is the final score, e_i is the variance contribution rate of the common factor, E is the cumulative variance contribution rate, and Y_i is the common factor.

Judge the influence of the variance contribution rate on the innovation and entrepreneurship ability.

4. Data processing

This study conducted an online survey through the Wenjuanxing platform, distributed and collected 89 valid questionnaires from the target group. During the survey, SPSSAU software was used for data cleaning and statistical analysis, providing an empirical basis for the subsequent conclusions.

4.1. KMO and Bartlett's Test of Sphericity

The KMO test provides an intuitive indicator of "correlation strength," while the Bartlett test verifies whether the correlation truly exists through statistical significance [16].

Table 1. KMO and Bartlett's Test of Sphericity

KMO Value		**0.85**
Bartlett's Test of Sphericity	Approximate chi-square	1115.655
	df	210
	p value	0

According to the analysis results in **Table 1**, the KMO value is greater than 0.6, and the *p*-value of Bartlett's sphericity test is less than 0.05. Therefore, the questionnaire results can be used for exploratory factor analysis.

4.2. Extraction of common factors

Using SPSSAU for standardization and exploratory factor analysis, after removing the influence of dimension, **Table 2** is obtained.

Table 2. Variance explained

Factor number	Eigenvalue			Initial Variance Explained			Rotated Variance Explained		
	Eigenvalue	% of Variance	Cumulative %	Eigenvalue	% of Variance	Cumulative %	Eigenvalue	% of Variance	Cumulative %
1	7.553	35.966	35.966	7.553	35.966	35.966	5.658	26.945	26.945
2	2.897	13.795	49.761	2.897	13.795	49.761	4.281	20.388	47.333
3	1.869	8.902	58.664	1.869	8.902	58.664	2.331	11.1	58.433
4	1.165	5.55	64.213	1.165	5.55	64.213	1.178	5.608	64.042
5	1.096	5.221	69.434	1.096	5.221	69.434	1.132	5.393	69.434
6	0.851	4.052	73.487						
7	0.838	3.99	77.476						
8	0.732	3.485	80.961						
9	0.626	2.982	83.943						
10	0.586	2.788	86.731						
11	0.441	2.102	88.833						
12	0.399	1.898	90.731						
13	0.372	1.77	92.501						
14	0.311	1.479	93.98						
15	0.27	1.284	95.264						
16	0.242	1.152	96.416						
17	0.198	0.943	97.359						
18	0.175	0.831	98.19						
19	0.149	0.708	98.899						
20	0.126	0.6	99.499						
21	0.105	0.501	100						

According to the data analysis results in **Table 2**, a total of 5 factors were extracted in this analysis, and the eigenvalue values were all greater than 1. The variance explained rates of these 5 factors after rotation were 26.945%, 20.388%, 11.100%, 5.608%, and 5.393% respectively. The cumulative variance explained rate after rotation was 69.434%. Since the explained rate was greater than 50%, it can be determined that the factor analysis results can be used for the construction of the innovation and entrepreneurship ability evaluation system.

4.3. Building an innovation and entrepreneurship evaluation system

Table 3. Rotated factor loading matrix

Name	Factor Loading Coefficients					Communality
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	
What is your major/field of study	0.065	-0.048	0.104	0.881	-0.088	0.802
What was your approximate academic performance ranking during university?	0.184	-0.112	0.361	-0.405	-0.549	0.642
How many innovation/entrepreneurship projects or educational practice programs have you participated in?	0.091	0.002	0.785	0.093	0.079	0.64
Have you received any awards or honors related to innovation/entrepreneurship?	0.118	0.026	0.853	0.017	0.026	0.744
Have any of your projects/practices been covered by media or gained social attention?	0.135	-0.022	0.786	-0.038	-0.084	0.644
When encountering new educational concepts or teaching methods, your attitude is:	0.513	-0.391	0.11	-0.143	-0.021	0.449
How would you rate your communication skills in team settings?	0.716	-0.091	0.328	0.099	0.107	0.65
How would you assess your mastery of educational theories (e.g., pedagogy, psychology)?	0.877	-0.101	0.118	0.054	0.034	0.798
When designing teaching plans, do you proactively incorporate interdisciplinary elements?	0.86	-0.098	0.101	0	-0.015	0.759
Are you prepared to anticipate and address sudden physical discomfort or psychological issues among students in class?	0.756	-0.297	0.033	-0.13	-0.077	0.684
Regarding future career planning, how do you perceive employment competition and uncertain career prospects?	0.704	-0.124	-0.044	0.065	-0.186	0.551
In your view, where does the primary professional value of teachers lie?	0.656	-0.341	-0.026	-0.236	0.172	0.633
How do you evaluate your comprehensive ability to design innovative lesson plans or teaching tools?	0.843	-0.03	0.127	0.1	0.094	0.747
How would you design homework assignments aligned with the “Double Reduction” policy requirements?	0.589	-0.433	0.05	-0.174	-0.016	0.567
How proficient are you with office software (e.g., Word, Excel, PowerPoint) in daily study/work?	0.717	-0.272	0.176	0.06	0.206	0.666
Which personal factors do you believe influence your innovation capability?	-0.136	0.877	-0.073	-0.065	0.042	0.8
Which external environmental factors do you think constrain innovation capability?	-0.088	0.797	0.065	-0.072	-0.029	0.654
Which policy supports would most enhance your confidence/ability in innovation/entrepreneurship?	-0.276	0.824	0.062	-0.106	0.046	0.772
How should your university strengthen “Education + Innovation” training?	-0.218	0.878	-0.013	0.097	-0.056	0.832
What types of practical support do you expect?	-0.215	0.864	-0.054	0.107	0.055	0.81
When facing a controversial educational issue, you tend to:	0.168	-0.007	0.12	-0.177	0.814	0.737

In this analysis, the main purpose is to screen out some factors affecting college students' innovation and entrepreneurship ability. Therefore, factors 1 (F1), 2 (F2), 3 (F3), 4 (F4), and 5 (F5) are not named, and only the impact analysis of factors with load coefficients greater than 0.4 is conducted.

From the table results, the following factors have relatively significant impacts on the evaluation of students' innovation and entrepreneurship capabilities: Major, Academic performance, Number of innovation and entrepreneurship projects participated in, Whether having won awards or honors related to innovation and entrepreneurship, Whether projects or practical activities have received media coverage or social attention, Communication skills, Mastery of educational theories such as pedagogy and psychology, Handling of sudden physical discomfort or psychological problems, Comprehensive ability to design new teaching plans or teaching aids, Proficiency in office software (such as Word, Excel, PowerPoint), Personal factors, External environmental factors, Policy support, How schools strengthen the cultivation of "education + innovation," Practical support, Standpoints on educational issues.

Drawing on the preliminary results of constructing the innovation and entrepreneurship evaluation system, the above factors can be summarized into the following categories: Firstly, External factors: According to the analysis results in the table, external factors include: Whether the participated innovation and entrepreneurship projects have received media coverage or social attention (i.e., social attention); Policy support and practical support, which can be collectively classified as the degree of external policy support. Secondly, Internal factors: Students' major, academic performance, communication skills, mastery of educational theories (such as pedagogy and psychology), proficiency in office software (e.g., Word, Excel, PowerPoint), and how schools strengthen the cultivation of "education + innovation" can all be classified as the mastery of relevant knowledge and skills by students; Whether having won awards or honors related to innovation and entrepreneurship can be classified as students' practical level; Handling of sudden physical discomfort or psychological problems, and standpoints on educational issues both reflect students' ability to independently solve problems.

Therefore, by analyzing the above results and screening the preliminary construction results of the innovation and entrepreneurship evaluation system, the final evaluation system is obtained as shown in **Figure 2**.

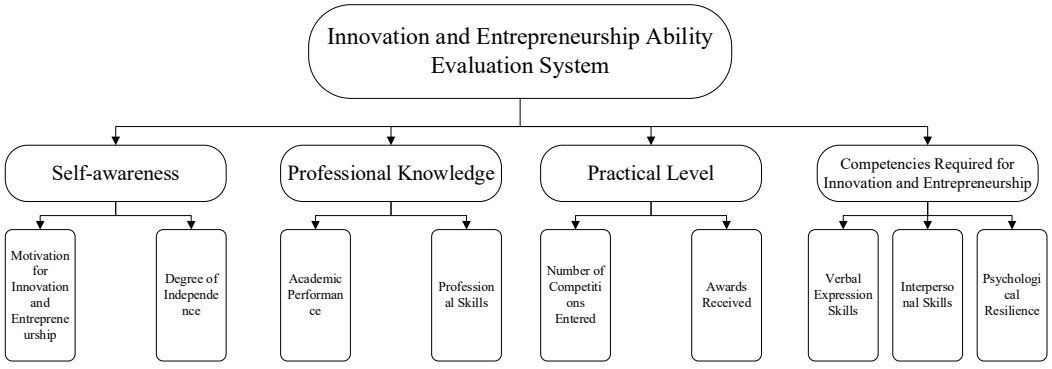

Figure 2. Innovation and entrepreneurship ability evaluation system.

5. Conclusion

Applying the factor analysis method to the innovation and entrepreneurship evaluation system can obtain relatively objective evaluations. Overall, the factor analysis method is more objective and comprehensive for indicator screening. Through factor analysis research, it is found that innovation and entrepreneurship motivation, independence, academic performance, professional skills, number of competitions participated in,

awards obtained, language expression ability, interpersonal communication ability, and psychological endurance have higher scores in the factor analysis method, showing a strong correlation with the construction of the innovation and entrepreneurship evaluation system.

Funding

Mid-term Results of the 2024 Langfang Normal University Special Teaching Reform Project on Innovation and Entrepreneurship Education Reform, "Research on the Evaluation System of Innovation and Entrepreneurship Ability for Normal University Students Based on Big Data Application—A Case Study of Langfang Normal University" (Project No.: CXJG2024-06)

Disclosure statement

The author declares no conflict of interest.

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