



Exploration of the Path of Iterative Upgrading of the Core Literacy of Innovative and Entrepreneurial Talents in Colleges and Universities under the Impact of Artificial Intelligence Technology to Cope with the Challenges of Future Job Competitiveness

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SUMMARY: *The study adopts a hybrid study of deconstructing the current situation and simulating the future, exploring and simulating the core literacy path of innovative and entrepreneurial talents in colleges and universities from two levels of static influence and dynamic evolution. The study constructed a structural equation model containing five antecedent variables (individual level and motivation, behavioral-emotional participation, learning environment, learning resources, and teacher competence) and three outcome variables (knowledge, practice, and psychological literacy), and tested the 15 theoretical hypotheses proposed. The system dynamics approach was also used to construct a simulation model of talent development. Three policy scenarios, namely, comprehensive development, high teacher allocation and atmosphere creation, were set to simulate the evolutionary trend of the three dimensions of core literacy over a five-year period by adjusting the time parameters of the corresponding influencing factors. Except for the two paths of "learning environment → knowledge level" and "resource learning → psychological quality" which did not reach significance, the remaining 13 paths were all supported. Among them, the standardized path coefficient of "individual level and motivation → knowledge level" was the highest, reaching 0.724. The high faculty allocation model is the most efficient in improving knowledge (4.23→4.75) and practical ability (4.46→4.80), while the atmosphere creation model achieves a reversal in psychological literacy cultivation with a score of 4.38 after five years, which is significantly better than the other models.*

KEYWORDS: *innovative and entrepreneurial talents; core literacy; factor analysis; structural equation modeling; system dynamics*

1 Introduction

Under the macro background of industrial structural adjustment and higher education towards connotative development, colleges and universities urgently need to think deeply about how to cultivate students' core qualities such as scientific and innovative thinking and humanistic literacy, and then improve their ability to analyze and solve complex problems, so as to make them grow up to be high-quality talents with exquisite professional skills and high moral integrity [1-4]. At present, innovation and entrepreneurship talent cultivation has become an important direction of higher education reform, but some colleges and universities lack professional understanding of innovation and entrepreneurship talent cultivation, resulting in students' insufficient ability to compete for future employment. On the one hand, the updating

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cycle of the curriculum lags behind the updating cycle of technology iteration, and the curriculum evaluation system is single, and does not effectively assess the core literacy such as innovative thinking, critical thinking, and problem-solving ability [5-7]. On the other hand, there is the phenomenon of “two skins” between professional courses and innovation and entrepreneurship education, and the interdisciplinary synergy is insufficient, and many students' projects stay in the stage of “talking on paper” and lack of real market demand verification [8, 9].

With the arrival of the artificial intelligence (AI) era, AI technology has penetrated into all aspects of economic and social development, and AI technology provides strong support and broad space for innovative and entrepreneurial talent cultivation [10]. In November 2024, the Ministry of Education convened a learning symposium, which emphasized that the talent cultivation mode should be shifted from “knowledge transfer-oriented” to “ability-based”. The Ministry of Education held a learning symposium in November 2024, emphasizing the shift of the talent training model from “knowledge transfer-oriented” to “competence and quality training first”, and the establishment of a new quality and new standards for talent training of “dare to break through and create”. New evaluation standards and systems should be established to accelerate AI-enabled innovation and entrepreneurship talent training, and to promote the formation of a good ecology that integrates innovation and entrepreneurship education and professional education, as well as intermingling and mutual promotion with digital education and wisdom education [11-14]. In the current wave of booming AI development, it is necessary to reconstruct the core literacy system and upgrade path of innovative and entrepreneurial talents, so as to cope with the challenges of future employment competitiveness.

The study first faces the many variables affecting innovation and entrepreneurship literacy such as knowledge level, interest attitude, platform resources, etc., purifies the questionnaire data by dimensionality reduction with the help of the factor analysis method, extracts the most representative common factors from the 18 observation items, and based on the structural equation modeling, examines whether the causality between them and the final literacy outcomes (knowledge, practice, and psychology) is established to validate the 15 hypotheses put forward in this paper and to quantify the strength of influence of each pathway. Finally, system dynamics simulation is introduced. The key influencing factors confirmed in the previous section, such as teacher level and environmental atmosphere, are transformed into model variables, and the mathematical rules for their interactions are set based on the DYNAMO equation. By adjusting the parameters such as the teacher input coefficient and the intensity of environmental creation, the dynamic evolution trend of talent literacy indicators under different model focuses in the next five years is simulated.

2 Factor analysis and theoretical construction of structural equation models

2.1 Factor analysis

2.1.1 Introduction to Factor Analysis Theory

Multivariate large samples, while providing rich information, also increase the workload of data collection to some extent. In most cases, there may be correlations between many variables, which increases the complexity of analyzing the problem. Due to the existence of certain correlations between variables, it is possible to synthesize the various types of information present in each variable with a small number of composite indicators that are not correlated with each other, i.e., the information represented by each indicator does not overlap. This allows

the composite indicators to be named according to specialized knowledge and the unique meaning reflected by the indicators. This method of analysis is called factor analysis, and the composite indicators representing various types of information are called factors or principal components. Based on the purpose of factor analysis, we know that the composite indicators should be fewer than the original variables, but should contain less relative loss of information.

Primary variables: $x_1, x_2, x_3, x_4 \dots x_p$

Principal components: $z_1, z_2, z_3, z_4 \dots z_m$

Then the relationship between the factors and the original variables can be expressed as:

$$\begin{aligned}
 x_1 &= b_{11}z_1 + b_{12}z_2 + b_{13}z_3 \dots + b_{1m}z_m + e_1 \\
 x_2 &= b_{21}z_1 + b_{22}z_2 + b_{23}z_3 \dots + b_{2m}z_m + e_2 \\
 x_3 &= b_{31}z_1 + b_{32}z_2 + b_{33}z_3 \dots + b_{3m}z_m + e_3 \\
 &\dots \dots \dots \dots \dots \dots \dots \dots \\
 x_p &= b_{p1}z_1 + b_{p2}z_2 + b_{p3}z_3 \dots + b_{pm}z_m + e_p
 \end{aligned}
 \tag{1}$$

It is written in matrix form as $X = BZ + E$. The values X are the vector of original variables, B is the matrix of male factor loading coefficients, Z is the vector of male factors, and E is the vector of residuals. The public factors $z_1, z_2, z_3 \dots z_m$ are uncorrelated with each other and are called orthogonal models. The task of factor analysis is to find the common factor loading coefficients and residuals.

An important purpose of factor analysis is also to provide a comprehensive evaluation of the number of original variables in a disaggregated manner. If the results of the factor analysis ensure orthogonality (uncorrelation) between the factors but do not make it easy to name the factors, it is also possible to make naming and interpreting the male factors easier by rotationally transforming the factor model so that the male factor loading coefficients change in the direction of greater (toward 1) or lesser (toward 0). Performing orthogonal exchange ensures that the factors remain orthogonal after the transformation, which is the preferred situation. If it is still not easy to interpret the common factors after orthogonal exchange, oblique rotation can also be performed. It may be possible to obtain a result that is easier to interpret.

Therefore, a complete factor solution should include both factor model and factor structure. Factor structure is to reflect the correlation between indicators and factors through correlation coefficients. The factor model is a linear combination of indicators x_1, x_2, \dots, x_p expressed as regression equations for factors z_1, z_2, \dots, z_m .

2.1.2 Specific steps of factor analysis

(1) Standardized transformation of raw data

$$x'_{ij} = \frac{x_{ij} - \bar{x}_i}{\sqrt{s_i}} \quad (i = 1, 2, \dots, m; j = 1, 2, \dots, n)
 \tag{2}$$

Among them: $\bar{x}_i = \frac{1}{n} \sum_{j=1}^n x_{ij}$

$$s_i = \frac{1}{n-1} \sum_{j=1}^n (x_{ij} - \bar{x}_i)^2
 \tag{3}$$

The initial factor loading array obtained from the factor model array may be difficult to interpret the factors if the size of the factor loadings does not differ much, therefore, in order to obtain clearer analysis results, each factor loading in the new coordinate system can be bipolarized by columns to 0 or 1 by rotating the coordinate axes, and also contains bipolarization by rows. There are two methods of rotation: orthogonal rotation and oblique rotation. As the rotation methods chosen are different, the results are different, and generally the final calculation result is the one that can get a clearer analysis result.

(6) Calculation of total score values

By rotating and calculating, the new more ideal factor loading matrix B'_1 and factor score coefficient matrix A are obtained. The total value of the scores for a given indicator for each region can be calculated by the following formula:

$$Z_i = \sum_{j=1}^m d_j z_i = \sum_{i=1}^m \sum_{j=1}^p d_i a_{ij} x_{ij} \quad (8)$$

where d_i is the factor contribution ratio; z_i is the factor score; a_{ij} is the factor score coefficient, which is obtained by inverting the transformed factor loadings B'_1 ; and x_{ij} is the normalized indicator value.

2.2 Basic theory of structural equations

2.2.1 Basic concepts of structural equation modeling

The basic concepts of structural equation modeling (SEM) are summarized as two types of variables, two models, and two paths. The two types of variables refer to: manifest variables and potential variables; the two models refer to: metric model and structural model; and the two paths refer to the path between potential variables and manifest variables, and the path between potential variables.

(1) Explicit variables: are variables that can be directly observed and measured, and can also be referred to as explicit variables, indicator variables, such as age, height, weight, etc.

(2) Latent variables: refers to factors or traits that cannot be directly measured, it may be a theoretical conception, a research hypothesis or an objective reality that cannot be precisely and directly measured by existing methods, but it can be measured by explicit variables, also known as latent variables, which are equivalent to the common factors in factor analysis. For example, behavioral problems cannot be directly observed, so it is a latent variable, but it can be measured by the entries related to the behavioral questionnaire.

(3) Endogenous variables: are variables that are influenced by or accounted for by other variables in a hypothesized causal model, i.e., commonly referred to as dependent variables, and can be considered to be the result of the joint action of exogenous variables and the remaining endogenous variables.

(4) Exogenous variables: variables that “cause” other variables and whose own changes are assumed to be determined by other factors outside the causal model, commonly referred to as independent variables.

(5) Another type of variable in SEM is the residual variable. The residual in SEM consists of three parts: the measurement error of the independent explicit variable, the measurement error of the non-independent explicit variable, and the residual term of the structural model. Although these residuals are also not directly observable, they are generally not considered as potential variables.

2.2.2 Structural equation modeling

Structural equation modeling is a method of statistical analysis that builds on an existing theory and represents that theory in terms of a corresponding system of linear equations. In simple terms structural equation modeling can be divided into measurement and structural models. Measurement models describe the relationship between latent variables and their manifest variables. Structural models, on the other hand, represent the relationship between latent variables.

(1) Measurement model

$$\begin{aligned} X &= \Lambda_x \xi + \delta \\ Y &= \Lambda_y \eta + \varepsilon \end{aligned} \quad (9)$$

In Eq:

X refers to the vector composed of exogenous indicators; Y is the vector composed of endogenous indicators; Λ_x is the relationship between the exogenous indicators and the exogenous latent variables, and it is the factor loading matrix of the exogenous indicators on the exogenous latent variables; Λ_y is the relationship between the endogenous indicators and the endogenous latent variables, and it is the factor loading matrix of the endogenous indicators on the endogenous latent variables; and δ refers to the error term of exogenous indicator X ; ε refers to the error term of endogenous indicator Y ;

(2) Structural model

$$\eta = \beta \eta + \Gamma \xi + \zeta \quad (10)$$

where η is the endogenous latent variable; ξ is the exogenous latent variable; β refers to the relationship between the endogenous latent variables; Γ refers to the effect of the exogenous latent variable on the endogenous latent variable; and ζ refers to the residual term of the structural equation, which reflects the portion of the equation that is unexplained by η ;

The relationship between the latent variables, i.e., the structural model, is usually the focus of interest in the study, so the entire analysis is also referred to as structural equation modeling.

2.3 Model Construction of Influencing Factors of Innovative and Entrepreneurial Talent Literacy in Colleges and Universities

2.3.1 Influencing factor variables of innovative and entrepreneurial talent literacy in colleges and universities

Based on literature research and expert interviews, the study establishes individual level and motivation, behavioral-emotional engagement, learning environment, learning resources, and teacher competence quality as five potential variables affecting innovative and entrepreneurial talent quality in universities, and Table 1 lists its 18 subdivided observational variables under the five influencing factors.

Table 1: Influencing factors of innovative and entrepreneurial talents in universities

Latent variable	Observable variable
Individual level and motivation	Innovation and entrepreneurship knowledge level
	Innovation and entrepreneurship skill level
	Interest and attitude
	Self-efficacy
Behavioral and emotional engagement	Perceived usability
	Perceived usefulness
	Innovation and creation behavior
	Collaborative exploration behavior
Learning environment	Campus innovation and entrepreneurship atmosphere
	Innovation and entrepreneurship platform
	Innovation and entrepreneurship facility configuration Available
Learning resources	Richness
	Construction of innovation and entrepreneurship resource library
	Innovation and entrepreneurship teaching methods
Teacher's competence and quality	Innovation and entrepreneurship teaching ability
	Innovation and entrepreneurship practical experience
	Innovation and entrepreneurship cognition
	Innovation and entrepreneurship knowledge level

And for the outcome variable of innovative and entrepreneurial talent literacy in colleges and universities, the study explores three aspects: knowledge level, practical ability and psychological literacy.

2.3.2 Relationship assumptions

The knowledge base and skill base of students constitute the capital of their ability to carry out innovation and entrepreneurship practices, which determines the height of their starting point. What is more critical is intrinsic motivation, which includes strong interest, positive attitude and a strong sense of self-efficacy. Therefore, it is hypothesized that

H1a: Individual level and motivation have a positive effect on the knowledge level of cultivating innovative and entrepreneurial talent literacy in colleges and universities;

H1a: Individual level and motivation have a positive effect on the practical ability of cultivating innovative and entrepreneurial talent literacy in colleges and universities;

H1a: Individual level and motivation have a positive effect on cultivating innovative and entrepreneurial talents' psychological literacy in colleges and universities;

When students perceive innovation and entrepreneurship activities as useful and easy to use, their willingness to participate and behavioral inputs are significantly enhanced. In this process, specific innovative and creative behaviors and collaborative inquiry behaviors simultaneously refine their abilities. Through practice, knowledge is applied, skills are enhanced, and psychological qualities such as stress tolerance are substantially developed. This hypothesis

H2a: Behavioral-emotional involvement has a positive effect on the knowledge level of cultivating innovative and entrepreneurial talents' literacy in colleges and universities;

H2b: Behavioral emotional involvement has a positive effect on the practical ability of cultivating innovative and entrepreneurial talent literacy in colleges and universities;

H2c: behavioral-emotional involvement has a positive effect on cultivating the psychological literacy of innovative and entrepreneurial talents in colleges and universities;

A strong campus innovation and entrepreneurship culture can subconsciously stimulate students' sense of identity and mission. Physical platforms and adequate facilities are equipped to provide essential physical support for the transformation from idea to prototype. For this hypothesis

H3a: The learning environment has a positive effect on the knowledge level of cultivating innovative and entrepreneurial talent literacy in universities;

H3b: The learning environment has a positive effect on the practical ability of cultivating innovative and entrepreneurial talent literacy in colleges and universities;

H3c: The learning environment has a positive effect on the psychological literacy of cultivating innovative and entrepreneurial talents in higher education;

The availability of learning resources ensures the fairness and timeliness of support; the richness and quality of resources directly determine the breadth of students' vision and the depth of their thinking. High-quality and cutting-edge information, cases, data and technology resources can effectively support their identification of opportunities, validation of ideas and optimization of solutions. Therefore, there are hypotheses

H4a: Learning resources have a positive effect on the knowledge level of cultivating innovative and entrepreneurial talent literacy in higher education;

H4b: Learning resources have a positive effect on the practical ability of cultivating innovative and entrepreneurial talent literacy in colleges and universities;

H4c: Learning resources have a positive effect on cultivating the psychological literacy of innovative and entrepreneurial talents in colleges and universities;

Teachers are not only knowledge transmitters, but also practice guides. Teachers with rich practical experience, advanced teaching methods and extensive industry networks are able to vividize theory and systematize practice, providing students with precise guidance and real project opportunities. Hypothesis

H5a: Teacher competence literacy has a positive effect on the knowledge level of cultivating innovative and entrepreneurial talent literacy in universities;

H5b: Teacher competence literacy has a positive effect on the practical ability of cultivating innovative and entrepreneurial talent literacy in colleges and universities;

H5c: Teacher competence literacy has a positive effect on cultivating innovative and entrepreneurial talent literacy in colleges and universities;

3 Data validation of the influence mechanism of innovative and entrepreneurial talent literacy in higher education institutions

Based on the above research hypotheses proposed, the previously constructed structural equation model was tested to explore the path and intensity of the influence of five latent variables, namely, individual level and motivation, behavioral-emotional engagement, learning environment, learning resources, and teachers' competence literacy, on the three dimensions of talent literacy (knowledge, practice, and psychology).

3.1 Questionnaire design, reliability and validity tests and sample description

The scales were first tested for reliability and factor structure exploration to ensure the scientific validity of the measurement tools.

3.1.1 Questionnaire design

Based on the above five influencing factors and outcome variables of the three dimensions of innovative and entrepreneurial talent literacy in colleges and universities, the study designed a corresponding questionnaire for this purpose. Questionnaire around the questionnaire college innovative and entrepreneurial talent literacy status quo and influencing factors each influencing factor dimension includes 3-7 items, while the college innovative and entrepreneurial talent literacy scale contains 6 items.

The scale of innovative and entrepreneurial talent literacy and influencing factors in colleges and universities includes 32 items, and each item of the questionnaire is rated according to the Likert scale of five levels, from “not at all consistent” to “completely consistent”, and the score is from 1 to 5, and the higher the score, the more consistent the description of the item is, and the more innovative the student is, the more the student is. The higher the score, the more consistent the description of the item is, and the better the students' innovation and entrepreneurship core literacy is.

3.1.2 Questionnaire reliability tests

The reasonableness and reliability of the results of a questionnaire are often measured by the reliability analysis of the reliability. Thus, the reliability of the questionnaire is an important criterion to measure the degree of consistency of the questionnaire, which makes the results of the questionnaire tend to be stable through repeated measurements of the questionnaire. The higher the consistency and stability of the questionnaire, the higher the reliability of the questionnaire. The reliability analysis of the scale is shown in Table 2. The results of the reliability test of this questionnaire show that the internal consistency alpha coefficient (Cronbach's α) of each dimension of the five influencing factors and outcome variables of innovative and entrepreneurial talents in colleges and universities ranges from 0.874-0.949, and the internal consistency of each part is very good, and the alpha coefficient of the whole scale is 0.942, which has a high reliability.

Table 2: Reliability analysis of the scale

	Ietm	Cronbach's α
Individual level and motivation	7	0.923
Behavioral and emotional engagement	7	0.929
Learning environment	3	0.949
Learning resources	3	0.874
Teacher's competence and quality	6	0.924
Impact Factor Checklist	26	0.906
Innovative and Entrepreneurial Talent Competence	6	0.931
Overall Questionnaire	32	0.942

3.1.3 Questionnaire retrieval and student descriptive analysis

Now the online distribution of electronic questionnaires and offline distribution of physical questionnaires in two forms of student research and analysis, for 28 colleges and universities, selected by the initial evaluation of the teacher's innovation and entrepreneurial talents in colleges and universities as the object of the study, a total of 500 questionnaires were issued, the actual recovery of 474, excluding 8 invalid questionnaires, the final valid questionnaires 468 questionnaires recovery rate of 94.8%, the questionnaire validity rate of 98.73%.

The basic information of 468 students is shown in Figure 1.

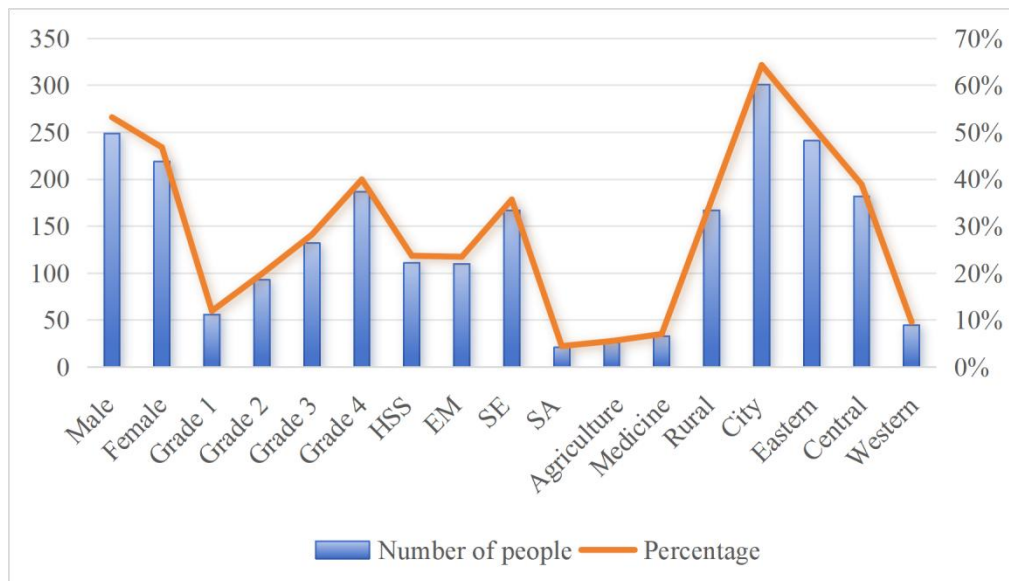


Figure 1: Basic information of 468 students

The ratio of men and women among the 468 interviewed innovative and entrepreneurial talents in colleges and universities is relatively balanced, with slightly more male than female students, with male students accounting for 53.21%. In terms of grade distribution, the proportion of senior students is the highest, amounting to 132/468, accounting for 39.96%, 28.21% of juniors, 19.87% and 11.97% of sophomores and freshmen respectively, and the sample is dominated by senior students. In terms of majors, science and engineering students are the most numerous, accounting for 35.68%, followed by humanities and social sciences and economics and management, each accounting for about 23.5%, and sports and arts, agriculture and medicine accounting for a relatively small proportion. In terms of student background, 64.32% of the students came from urban areas and 35.68% from rural areas. In terms of school geographic distribution, more than half of the students were located in eastern colleges and universities ($241/468 = 51.50\%$), with 38.89% in the center. The sample has some variability in terms of grade, specialty and geography, which initially reflects the current characteristics of the composition of innovative and entrepreneurial talents in colleges and universities.

3.2 Factor analysis of influencing factors

3.2.1 Total Variance Explained

Factor analysis was conducted on the questionnaire of the Influence Factor Scale for Innovative and Entrepreneurial Talents in Colleges and Universities, which contains 18 indicators and 26 items, and 4 factors with eigenvalues more than 1 were extracted, and the eigenvalues of the 4 common factors in the first part of the pivot were 24.826, 10.559, 6.412, and 1.613, which explained 36.761%, 17.228%, 11.561%, and 4.465%, respectively of the The four common factors can explain 70.015% of the variance of the questionnaire items. The total variance explained by factor analysis of factors influencing innovative and entrepreneurial talents in colleges and universities is shown in Table 3.

Table 3: Factor analysis explains the total variance

		Factor			
		1	2	3	4
Initial eigenvalue	Total	24.826	10.559	6.412	1.613
	Variance %	36.761	17.228	11.561	4.465
	Cumulative %	36.761	53.989	65.55	70.015
Extracted load squared sum	Total	24.826	10.559	6.412	1.613
	Variance %	36.761	17.228	11.561	4.465
	Cumulative %	36.761	53.989	65.55	70.015
Rotated load squared sum	Total	21.320	9.824	7.384	5.115
	Variance %	30.342	16.077	13.186	10.41
	Cumulative %	30.342	46.419	59.605	70.015

The gravel plot of the 26 topic-item factors of the factors influencing innovative and entrepreneurial talents in higher education is shown in Figure 2.

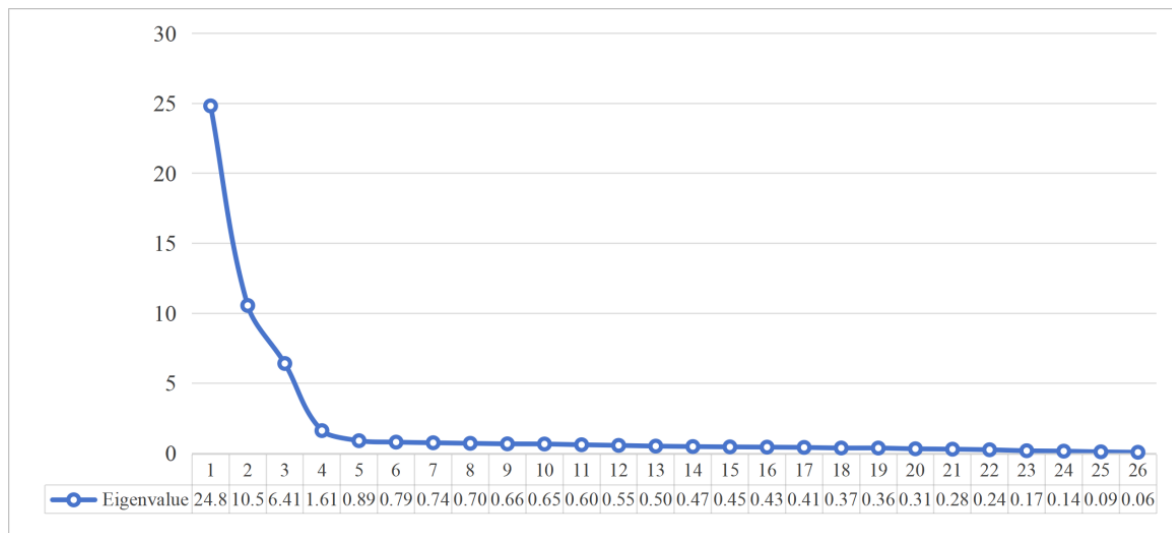


Figure 2: Fragmentation chart of affecting students' IET factors

The gravel plot shows that there are only 4 factors with eigenvalues greater than 1, again confirming that it is more appropriate to extract 4 male factors.

3.2.2 Factor matrix after rotation

The extracted factors were then subjected to the maximum variance method operation to rotate and analyze the 26 question items, and the rotated factor matrix is shown in Table 4.

Table 4: The rotated factor matrix

Item	Factor1	Factor2	Factor3	Factor4
ILM1	0.808	-0.005	0.015	0.014
ILM2	0.746	-0.077	0.112	0.103
ILM3	0.702	0.017	0.254	0.059
ILM4	0.831	0.066	0.121	-0.047
ILM5	0.823	0.076	-0.015	0.023
ILM6	0.704	0.003	0.079	-0.045
ILM7	0.799	0.137	0.055	0.302
BEE1	-0.012	0.805	0.049	-0.005
BEE2	0.042	0.842	0.111	0.039
BEE3	0.107	0.707	0.254	0.095
BEE4	0.115	0.876	0.065	0.103
BEE5	0.006	0.685	0.086	0.357
BEE6	0.079	0.789	0.012	-0.015
BEE7	0.122	0.656	0.313	0.054
LE1	0.075	0.112	0.101	0.699
LE2	0.021	0.116	0.048	0.715
LE3	0.071	0.068	0.066	0.698
RL1	0.022	0.049	0.028	0.697
RL2	0.113	0.204	0.033	0.746
RL3	0.106	0.214	0.025	0.701
TCQ1	-0.103	0.107	0.694	0.109
TCQ2	0.208	0.115	0.724	0.008
TCQ3	0.123	0.206	0.752	-0.042
TCQ4	0.003	0.079	0.853	0.064
TCQ5	0.013	0.122	0.805	0.056
TCQ6	0.001	0.005	0.763	0.063

After being rotated by the maximum variance method, the 26 question items were more clearly attributed to the four components. Specifically, Component 1 mainly contains the seven items of individual level and motivation, with factor loadings generally in the range of 0.702 to 0.831, and the items are highly aggregated, together reflecting students' knowledge, skills and motivation levels. Component 2, on the other hand, corresponded to the 7 question items of Behavioral Emotional Involvement, with loadings ranging from 0.656 to 0.876. Component 3 concentrates on the 6 items of Teacher Competence Literacy, with loadings ranging from 0.694-0.853. Component 4 annexes the 6 items of Learning Environment and Learning Resources, with a distribution of loadings ranging from 0.697-0.746. In the actual factor structure, students' perception of environment and resources has strong internal consistency. Overall, the factor structure is clear, and the factor loadings of each question item are >0.6 , with clear attribution, allowing for subsequent structural equation modeling.

3.3 Data normality test

After the initial establishment of the measurement structure through factor analysis, in order to comprehensively assess the overall fitness of the model and the normality of the variables, the model's 32 questionnaire items were then subjected to descriptive statistics and normal distribution tests. The descriptive statistics of the 32 observed variables are shown in Table 5.

Table 5: Descriptive statistics of 32 observation variables

		Min	Max	Mean	SD	Skewness	Kurtosis	Skewness Kurtosis
Individual level and motivation	ILM1	1	5	3.88	1.67	0.315		1.189
	ILM2	1	5	4.25	1.24	-1.058		0.391
	ILM3	1	5	4.06	0.84	-0.084		-0.636
	ILM4	1	5	4.23	1.73	-0.628		0.798
	ILM5	2	5	4.48	1.87	-0.078		-1.156
	ILM6	1	5	4.28	0.68	0.983		0.781
	ILM7	2	5	4.33	0.98	-0.547		-0.034
Behavioral and emotional engagement	BEE1	1	5	3.87	1.49	1.019		0.043
	BEE2	1	5	3.82	1.14	-0.653		-0.012
	BEE3	1	5	3.80	1.13	-0.107		-0.468
	BEE4	1	5	4.03	1.30	0.181		-1.008
	BEE5	2	5	4.41	1.06	0.382		-0.576
	BEE6	1	5	4.23	1.71	1.227		0.952
	BEE7	2	5	4.39	1.71	-0.396		-0.263
Learning environment	LE1	1	5	4.03	1.37	-0.316		0.056
	LE2	1	5	3.71	0.79	1.207		1.036
	LE3	1	5	3.93	1.13	0.561		-0.640
Learning resources	RL1	1	5	3.82	1.07	-0.506		0.501
	RL2	1	5	4.32	0.97	1.243		-0.833
	RL3	1	5	3.56	1.86	0.659		-1.101
Teacher's competence and quality	TCQ1	1	5	3.79	1.29	0.523		1.232
	TCQ2	1	5	4.02	1.64	0.469		-0.295
	TCQ3	1	5	4.12	1.77	0.87		-0.029
	TCQ4	1	5	3.67	1.99	0.976		-1.118
	TCQ5	1	5	3.51	2.05	1.005		0.174
	TCQ6	1	5	3.29	1.67	0.399		1.011
Qualities of innovative and entrepreneurial talents	IEL1	1	5	4.17	1.58	1.246		0.059
	IEL2	1	5	4.29	0.96	-0.942		1.202
	IEL3	1	5	4.59	0.67	-1.248		-0.019
	IEL4	1	5	4.32	1.35	0.036		-0.262
	IEL5	1	5	3.72	0.89	-0.779		1.268
	IEL6	1	5	3.84	1.51	1.065		0.567

When the data satisfy the conditions that the absolute value of skewness is less than 3 and the absolute value of kurtosis is less than 8 at the same time, it indicates that the sample basically obeys a normal distribution. And the results of 468 samples under 32 observed variables in Table 6 of the descriptive statistics satisfy these two conditions at the same time, indicating that the data collected in this questionnaire basically show normal distribution, and can be continued to follow up the analysis based on structural equation modeling.

At the same time, the students' total score for their own dimensions of individual level and motivation and behavioral-emotional involvement is higher, with 4.22 and 4.08 for each item respectively, while the dimensions of external influences such as the learning environment, learning resources and teachers' competence and quality are evaluated a little lower and have a larger standard deviation, with the average scores for each of the questions of the three dimensions of 3.89 ± 1.76 , 3.90 ± 1.82 , and 3.73 ± 1.90 , respectively, indicating that the data collected in this questionnaire are basically normally distributed. It shows that the evaluation differences between different students in different schools are large and the degree of dispersion is high. 468 students' average score for the 6-item item of innovative and entrepreneurial literacy is 4.16, which is at a high level, indicating that the innovative and entrepreneurial talent literacy of the initial selection of each school performs well in the level of knowledge, practical ability and psychological literacy.

3.4 Structural equation modeling path tests

On the basis of ensuring that the data meet the requirements of structural equation modeling analysis, the structural equation model of the influence mechanism of innovative and entrepreneurial talent literacy in colleges and universities is now constructed and tested.

3.4.1 Statistics on parameter estimates of impact factor models

Firstly, the parameter estimates of the corresponding dimensions of each topic item of the influence model of innovative and entrepreneurial talent literacy in colleges and universities were statistically analyzed, and the statistical results are shown in Table 6.

Table 6: Estimation of dimension parameters for each item

	Unstd.	S.E.	C.R.	P	Std.
Knowledge level→ILM	1.000				
Skill level→ILM	1.000				
Interest attitude→ILM	0.935	0.084	12.044	0.000	0.680
Self-efficacy→ILM	0.947	0.047	11.043	0.000	0.672
Perceived usability→BEE	0.756	0.063	9.613	0.000	0.679
Perceived usefulness→BEE	0.934	0.089	12.458	0.000	0.818
Innovative creation behavior→BEE	0.825	0.077	11.587	0.000	0.772
Collaborative inquiry behavior→BEE	0.715	0.092	9.732	0.000	0.725
Campus IE atmosphere→LE	0.816	0.06	12.684	0.000	0.747
IE platform→LE	1.000				
IE facility→LE	0.945	0.091	10.875	0.000	0.863
Availability→RL	0.837	0.063	12.135	0.000	0.672
Richness→RL	0.924	0.096	12.960	0.000	0.838
IE resource library→RL	1.000				
IE teaching methods→TCQ	0.944	0.082	12.286	0.000	0.764
IE teaching ability→TCQ	1.000				
IE practical experience→TCQ	0.975	0.077	10.220	0.000	0.836
IE cognition→TCQ	0.776	0.054	9.701	0.000	0.788
Knowledge level→IEL	0.618	0.069	13.150	0.000	0.829
Practical ability→IEL	0.883	0.084	12.046	0.000	0.832
Psychological quality→IEL	0.874	0.052	9.109	0.000	0.706
ILM1→Knowledge level	1.011	0.07	10.898	0.000	0.795
ILM2→Knowledge level	0.915	0.063	12.904	0.000	0.918
ILM3→Skill level	0.983	0.053	9.728	0.000	0.777
ILM4→Skill level	0.917	0.076	10.655	0.000	0.670
ILM5→Interest attitude	1.099	0.101	10.047	0.000	0.852
ILM6→Interest attitude	0.896	0.093	10.464	0.000	0.886
ILM7→Self-efficacy	0.876	0.059	10.927	0.000	0.885
BEE1→Perceived usability	1.117	0.084	10.704	0.000	0.790
BEE2→Perceived usefulness	1.061	0.06	12.365	0.000	0.775
BEE3→Perceived usefulness	0.886	0.077	9.605	0.000	0.753
BEE4→Innovative creation behavior	0.975	0.104	10.052	0.000	0.865
BEE5→Innovative creation behavior	0.948	0.063	10.904	0.000	0.863
BEE6→Collaborative inquiry behavior	0.969	0.082	11.647	0.000	0.784
BEE7→Collaborative inquiry behavior	0.988	0.060	12.755	0.000	0.802
LE1→Campus IE atmosphere	1.000				
LE2→IE platform	1.000				
LE3→IE facility	1.000				
RL1→Availability	1.000				
RL2→Richness	0.967	0.077	12.544	0.000	0.894
RL3→IE resource library	1.000				
TCQ1→IE teaching methods	0.919	0.058	13.285	0.000	0.829
TCQ2→IE teaching methods	0.982	0.068	11.510	0.000	0.753
TCQ3→IE teaching ability	0.912	0.09	11.346	0.000	0.862
TCQ4→IE teaching ability	0.941	0.067	12.967	0.000	0.791
TCQ5→IE practical experience	1.000				
TCQ6→IE cognition	1.000				
IEL1→Knowledge level	1.000				
IEL2→Knowledge level	1.041	0.066	11.375	0.000	0.733
IEL3→Practical ability	1.011	0.055	9.739	0.000	0.891
IEL4→Practical ability	1.103	0.088	13.221	0.000	0.684
IEL5→Psychological quality	1.043	0.05	11.812	0.000	0.756
IRL6→Psychological quality	1.117	0.049	9.895	0.000	0.849

When the value of C.R. is less than 2, it means that the variable influence role is not obvious and the variable needs to be deleted or reset. From Table 6, it can be seen that all the values of the variables are greater than 2, so the variable influence role is obvious and does not need to be deleted or reset. When the P-value is >0.01 , it means that the level of influence is not significant, and the relationship between the variables in the above table $P=0.000<0.01$, which is significant at the 0.001 level. The standardized estimates of the above parameters are all greater than 0.6. Therefore, no violation of the estimates exists in the structural equation model of the factors influencing innovative and entrepreneurial talent literacy in universities. The effect of each item and variable or each observed variable and dimension is significant. The unstandardized coefficients of “skill level→individual level and motivation”, “innovation and entrepreneurship platform→learning environment”, and so on, were fixed at 1.000 when the items corresponded to a single sub-dimension, which was necessary for model identification and did not affect their actual meanings. Overall, the quality of the measurement model is good, and each observed variable can measure its corresponding latent variable stably and significantly, which lays a credible foundation for the subsequent structural model path analysis.

3.4.2 Model path analysis

The model structure model path coefficient statistics are shown in Table 7.

Table 7: Estimation of dimension parameters for each item

	Unstd.	S.E.	C.R.	P	Std.
Individual level and motivation → Knowledge level	0.724	0.078	8.012	0.000	0.672
Individual level and motivation → Practical ability	0.687	0.071	8.267	0.000	0.645
Individual level and motivation → Psychological quality	0.612	0.069	7.420	0.000	0.598
Behavioral and emotional engagement→ Knowledge level	0.588	0.065	7.508	0.000	0.521
Behavioral and emotional engagement→ Practical ability	0.623	0.062	8.435	0.000	0.587
Behavioral and emotional engagement→ Psychological quality	0.561	0.058	7.948	0.000	0.503
Learning environment → Knowledge level	0.182	0.049	1.673	0.095	0.089
Learning environment → Practical ability	0.394	0.055	7.164	0.000	0.432
Learning environment → Psychological quality	0.325	0.053	6.132	0.000	0.361
Resource learning → Knowledge level	0.376	0.051	7.373	0.000	0.418
Resource learning → Practical ability	0.408	0.054	7.556	0.000	0.447
Resource learning → Psychological quality	0.171	0.042	1.691	0.091	0.078
Teacher's competence and quality→ Knowledge level	0.553	0.059	7.678	0.000	0.496
Teacher's competence and quality→ Practical ability	0.662	0.067	8.388	0.000	0.614
Teacher's competence and quality → Psychological quality	0.423	0.056	6.911	0.000	0.423

Based on the 15 paths derived, each influencing factor basically plays a significant role in the three dimensions of innovative and entrepreneurial talent literacy in colleges and universities. The standardized path coefficients of individual level and motivation in the three dimensions of knowledge level, practical ability and psychological literacy are 0.724, 0.687 and 0.612, respectively, and all of them are significant at the 0.001 level. The verification of hypotheses H1a, H1b and H1c indicates that students' own knowledge base, skill reserve, interest attitude and self-efficacy play a positive driving role in the development of comprehensive innovation and entrepreneurship literacy.

The path coefficients of behavioral-emotional involvement on the three dimensions of innovation and entrepreneurship literacy are 0.588, 0.623 and 0.561, respectively, all of which

also play a positive role in influencing the development of innovation and entrepreneurship literacy, in line with hypotheses H2a, H2b and H2c.

The impact of learning environment appears to be differentiated. It has a significant positive impact on practical ability and psychological literacy, with path coefficients of 0.394 and 0.325, validating hypotheses H3b and H3c, but its path of impact on knowledge level does not reach statistical significance ($P=0.095, Std.=0.089$), and hypothesis H3a is not valid, eliminating this path.

The resource learning impact is equally selective. Its positive impact on knowledge level and practical competence is significant (path coefficients=0.376 and 0.408), supporting hypotheses H4a and H4b. However, its direct path on psychological literacy is not significant, with a path coefficient of only 0.171, $C.R=1.691 < 2.0$, $P=0.091, Std.=0.078$, and hypothesis H4c is not valid.

All 3 paths are valid for teacher competence literacy and their standardized path coefficients are 0.553, 0.662 and 0.423 for knowledge, practical and psychological dimensions respectively, all of which are significant. Hypothesis H5 series was supported.

Finally, the two paths of learning environment \rightarrow knowledge level and resource learning \rightarrow psychological literacy were excluded, and 13 paths of innovation and entrepreneurship literacy influence were retained.

4 Simulation study of innovative and entrepreneurial talent cultivation model based on system dynamics

Based on the above empirical evidence obtained through structural equation modeling of the role of each influencing factor on innovation and entrepreneurship talent literacy in colleges and universities, this chapter introduces the system dynamics method to construct a simulation model of innovation and entrepreneurship talent cultivation system in colleges and universities.

4.1 Simulation Modeling Algorithm

The ultimate purpose of establishing a simulation model based on system dynamics is to apply the computer simulation results of the process of innovative and entrepreneurial talent cultivation strategies and behavioral strategies of universities to obtain coordinate images and two-dimensional icons. The basic DYNAMO equation of the model is designed according to the operation mechanism of the simulation model, and the specific formula of the level equation of the simulation model (L equation) is as follows:

$$L_1 \cdot K = L_1^* J + DK^* (R_i \cdot JK - R_o \cdot JK) \quad (11)$$

In Eq. (11), the level variable L is the product variable, the rate variable R is the product variable, and DK and JK are auxiliary variables.

The rate equation (R equation) of the simulation model is specifically formulated as follows:

$$R_1 \cdot KL = f(L_1 \cdot K, \Lambda_1 \cdot K, \dots) \quad (12)$$

In Eq. (12), the level variable L and the rate variable R are the product variables, and K and Λ are the auxiliary variables.

The auxiliary equations (Λ equations) of the simulation model are specified as follows:

$$\Lambda_1 \cdot K = g(L_1 \cdot K, \Lambda_2 \cdot K, R_1 \cdot JK, \dots) \quad (13)$$

The initial value of C is assigned to 51 and the initial value of L_1 is 28 according to the actual situation of enrollment and employment in Chinese universities.

The basic steps for running the simulation model built based on system dynamics are as follows:

- (1) Input the program and input the original data.
- (2) Calculate and output the number of students graduating from universities with entrepreneurial and innovative talents in the next five years according to the initial parameter design values.
- (3) Adjust the enrollment coefficient and the social resource coefficient of universities to observe the changes in the number of students graduating from universities with entrepreneurial and innovative talents in the next five years.
- (4) Adjust the coefficient of total knowledge of colleges and universities and the coefficient of professional skill training, and observe the changes in the number of graduates of entrepreneurial and innovative talents in colleges and universities in the next five years.
- (5) Determine the target value of the number of students graduating from colleges and universities with entrepreneurial and innovative talents in the next five years, adjust the coefficients of each product, and observe the changes in the results.
- (6) Repeat the cycle (3) to (5) until the simulation obtains the best BRF value, and formulate a reasonable strategy of social resource utilization and university talent cultivation strategy.

4.2 Setting a model for the development of students' core literacy in innovation and entrepreneurship

Based on the results of the questionnaire survey and analysis of 468 innovative and entrepreneurial talents in universities mentioned above, this study used the system dynamics simulation software Vensim PLE v7.3 to analyze the system dynamics. The study set the system simulation year as 5 years. In order to test the optimal development model and macro trends suitable for cultivating students' innovative and entrepreneurial literacy, this study summarizes three different development models based on the results of the questionnaire data and different scholars' research on school education and organization models: the comprehensive development model¹, the high faculty staffing development model², and the atmosphere-creating development model³.

4.2.1 Integrated development model

In the integrated development model, all stakeholders in the complex ecosystem of education focus on the goal of cultivating students' innovative and entrepreneurial literacy, focusing on stimulating students' intrinsic motivation and participation behaviors, as well as simultaneously improving the learning environment, resource supply and teachers' ability, and coordinating the five influencing factors to make them work in a synchronized and appropriate manner. In this model, the corresponding time parameters of each factor are set at moderate values. Parameters T1/T2, which drive the accumulation of individual level and motivation, and behavioral and affective engagement, are set at 0.55, and parameters T3/T4/T5, which regulate the release of learning environment, resources, and teacher competence, are set at 0.50. This model can be used as a baseline scenario for evaluating the effectiveness of other strategies.

4.2.2 High Teacher Staffing Development Model

The model focuses on strengthening the key lever of teacher competence. Based on the comprehensive development model, the model significantly increases the investment in teacher competence, practical guidance and cognitive leadership, while the parameters of learning resources and learning environment support remain unchanged ($T3/T4=0.50$). In the simulation system, the parameter T5, which affects teacher competence, is increased from the baseline level of 0.50 to 0.85. At this time, the parameters T1 and T2, which represent student autonomy, are also maintained at the baseline level to simulate the development path of student literacy under strong external guidance.

4.2.3 Atmosphere Creation Development Model

The model emphasizes the endogenous motivation of students through the creation of a positive learning environment, focusing on ambient empowerment. In terms of parameter setting, T3, a parameter related to environment creation, was set at a higher level of 0.80, and other parameter settings were consistent with the comprehensive development model.

4.3 System Simulation and Result Analysis

The impact on innovation and entrepreneurship talent literacy under the 3 development modes is explored by observing the change trends of the three dimensions of students' knowledge level, practical ability and psychological literacy. Figures 3, 4, and 5 show the trends of the three dimensions of students' knowledge level, practical ability, and psychological literacy under the 3 development modes over 5 years, respectively. (Year 0 data is based on the current status scores of 468 college students' innovative and entrepreneurial literacy in Table 5).

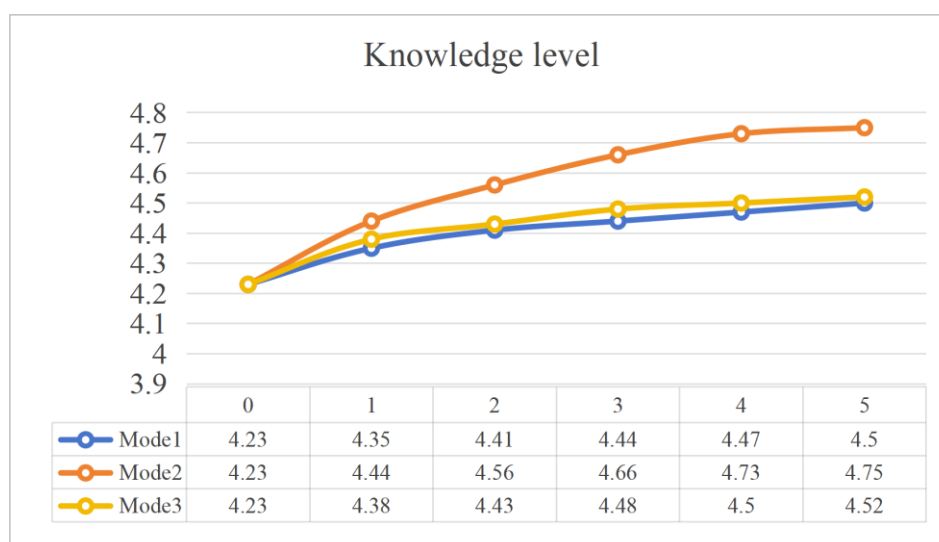


Figure 3: The trend of knowledge level changes in the three modes

Students' initial knowledge level has been in the good upper range of 4.23 points. All three models showed a consistent upward trend over time. The High Teacher Allocation Development model showed the most outstanding performance, with the knowledge level already increasing from year 1 to 4.44 points, an increase of 4.96%, and to 4.75 points in year 5, a total increase of 0.52 points. It shows that increased investment in teachers' teaching ability, practical guidance and cognitive leadership can most directly and effectively contribute to the transfer and internalization of explicit knowledge. Going back to Table 7 shows that the path

coefficient of teacher competence literacy → knowledge level is 0.553, which corresponds to it. At the same time, the Climate Creation Development Model 2 also increased from 4.38 to 4.52 points in the first year, an increase of 0.29 points, which is slightly better than the Comprehensive Development Model (from 4.35 to 4.50 points, an increase of 0.27 points). The role of active learning environments in supporting knowledge accumulation was verified, echoing hypothesis H3a.

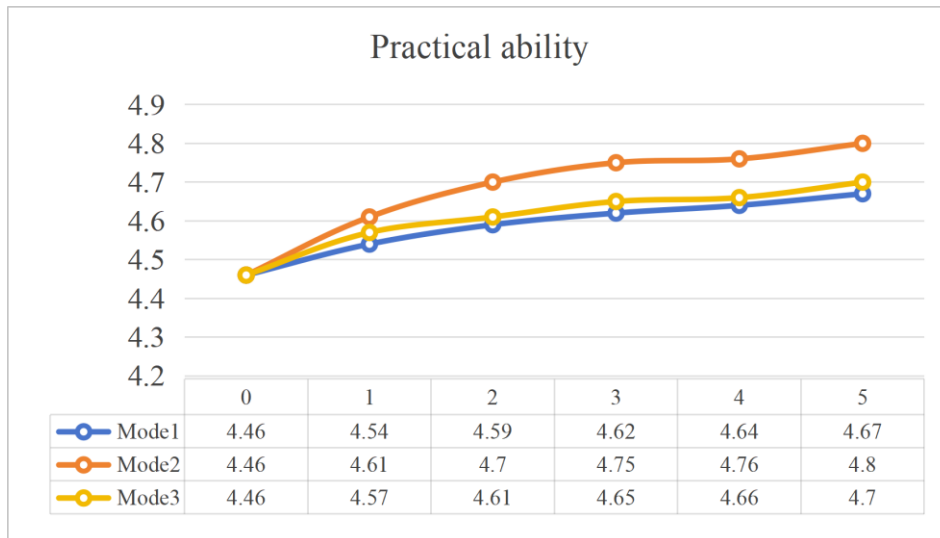


Figure 4: The trend of practical ability changes in the three modes

The trend of change in practical ability is similar to the level of knowledge. Because the 468 students in the initial selection were already innovative and entrepreneurial in higher education, their initial practice competencies had reached a mean score of 4.46. Over the five years of the simulation, the high teacher staffing model again led the growth, from 4.61 in year 1 to 4.80 in year 5, a total increase of 0.34 points. Corroborating the structural equation modeling of the teacher competency literacy-to-practice competency path coefficient = 0.662, the climate creation model again slightly outpaced the comprehensive development model in practice competency growth, with the former moving from 4.57 → 4.70 and the latter from 4.54 → 4.67, with the former consistently leading the latter by 0.02-0.03 points.

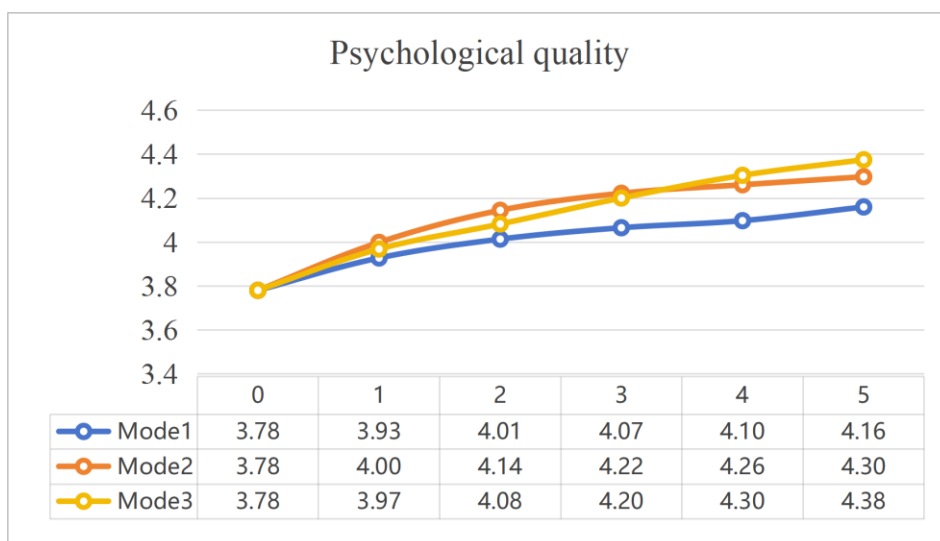


Figure 5: The trend of psychological quality changes in the three modes

The initial psychological literacy score is only 3.78, which is a relative shortcoming in the cultivation of innovative and entrepreneurial talents in colleges and universities at present. The development mode of atmosphere creation realizes a counter-attack on the improvement of psychological literacy, climbing from 3.97 points in the first year to 4.38 points in the fifth year, with an increase of 0.60 points, and finally surpassing the other two modes. This coincides with the significant positive effect of learning environment on psychological literacy in the previous path analysis (learning environment \rightarrow psychological literacy path coefficient = 0.325). A positive and supportive campus culture and environment is more effective in relieving student stress and fostering innovation. Similarly, considerable growth in psychological literacy was realized in the high faculty staffing model, with a total increase of 0.52 points from 4.00 to 4.30, indicating that faculty guidance and encouragement are equally important.

5 Conclusion

Through a valid questionnaire survey of 468 innovative and entrepreneurial talents from 28 colleges and universities across China (overall reliability of the questionnaire Cronbach's $\alpha = 0.942$), factor analysis was utilized to downscale the 18 observed variables, and four key public factors were successfully extracted, which cumulatively explained 70.015% of the variance. The structural equation modeling fitting results revealed that two paths, learning environment \rightarrow knowledge level and resource learning \rightarrow psychological literacy, were not significant, with path coefficients of 0.182 and 0.171, respectively, and hypotheses H3a and H4c were not valid. The remaining 13 paths are all significant, and teacher competence literacy demonstrates a comprehensive driving role, with path coefficients of 0.553, 0.662 and 0.423 for the three aspects of core literacy in innovation and entrepreneurship, providing theoretical support in subsequent simulation experiments based on system dynamics. Its knowledge level and practical ability reached 4.75 and 4.80 respectively in 5 years under the high faculty configuration mode. Based on this paper, we are oriented to the exploration of the influence mechanism of innovative and entrepreneurial talents' core literacy in colleges and universities and the simulation of dynamic cultivation paths to construct a dynamically adapted talent cultivation system.

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