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# INFLUENCING FACTORS ON COLLEGE STUDENTS' INNOVATIVE LITERACY BASED ON SEM: TAKING PRIVATE UNIVERSITIES IN GUANGDONG PROVINCE AS A CASE STUDY

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**Abstract:** Under the background of the national strategy of innovation-driven development and the deepening advancement of "mass entrepreneurship and innovation" education in higher education institutions, this study focuses on 210 undergraduate students from private universities in Guangdong Province. Based on social cognitive theory and ecological systems theory, a four-dimensional model comprising "individual-teacher-university-national policy" was constructed. Innovative self-efficacy was introduced as a mediating variable, with empirical analysis conducted using SPSS and Amos. Results indicate that university students' innovative awareness, teaching resources, institutional training mechanisms, and national policies all demonstrate significant positive direct correlations with innovative literacy, among which innovative awareness exhibits the strongest association intensity. The four-dimensional factors also show significant positive correlations with innovative self-efficacy, which plays a mediating role in the relationships between these factors and innovative literacy. This study provides an empirical basis for private universities to optimize their innovation education systems.
**Keywords:** Private higher education institutions; Innovative literacy of college students; Structural equation modeling; Innovative self-efficacy

## 1 INTRODUCTION

The National Innovation-Driven Development Strategy and a series of "mass entrepreneurship and innovation" educational policies have imposed new requirements on talent cultivation in higher education institutions. As critical bases for cultivating applied talents, private higher education institutions face particular challenges and urgency in fostering innovative literacy due to their diverse student cohorts and relatively limited resources. Existing studies have primarily focused on public universities, with quantitative empirical research remaining scarce regarding private institutions, particularly in terms of adequate exploration of the mechanisms through which various factors operate. Therefore, this study aims to systematically uncover key influencing factors and their mechanisms of action affecting innovative literacy among students at private higher education institutions in Guangdong Province through quantitative methodologies.

This research constructs an analytical model from a multi-level systems perspective, grounded in Social Cognitive Theory and Ecological Systems Theory as theoretical frameworks [1,2]. The methodology is based on Structural Equation Modeling (SEM) theory, which enables simultaneous handling of latent variable measurements and path relationships between variables, making it suitable for testing the complex hypotheses involved in this study [3].

## 2 STUDY DESIGN

### 2.1 Theoretical Model and Research Hypothesis

This study constructs a theoretical model with four exogenous latent variables: "innovative consciousness of college students", "faculty resources", "institutional training mechanisms" and "national policies", "innovation self-efficacy" as the mediating variable, and "college students' innovative literacy" as the endogenous latent variable. Based on this model, ten research hypotheses were proposed, as presented in Table 1.

**Table 1** Research Hypotheses on the Influencing Factors of Innovation Literacy among College Students

| Research Hypothesis | Number | Research Hypothesis |
|---|---|---|
| Direct effect hypothesis | H1 | University students' innovative awareness is significantly positively correlated with their innovative literacy |
| | H2 | Faculty resources demonstrate a significant positive correlation with university students' innovative literacy. |
| | H3 | Institutional training mechanisms show a significant positive association with university students' innovative literacy. |
| | H4 | National policies exhibit a significant positive relationship with university students' innovative literacy |

| | | |
|---|---|---|
| | H5 | University students' innovative awareness has a significant positive correlation with their innovative self-efficacy. |
| | H6 | Faculty resources are significantly positively associated with university students' innovative self-efficacy. |
| | H7 | Institutional training mechanisms display a significant positive correlation with university students' innovative self-efficacy. |
| | H8 | National policies present a significant positive relationship with university students' innovative self-efficacy. |
| | H9 | Innovative self-efficacy shows a significant positive correlation with university students' innovative literacy. |
| Mediating effect hypothesis | H10 | Innovative self-efficacy demonstrates significant mediating pathway effects in the relationships between university students' innovative awareness, faculty resources, institutional training mechanisms, national policies, and innovative literacy. |

### 2.2 Questionnaire Design and Data Collection

The questionnaire comprises 37 items across 6 latent variables, all measured using a 5-point Likert scale. The measurement items were adapted from established scales in the literature [4-7], and an online survey was conducted targeting undergraduate students at private higher education institutions in Guangdong Province. A total of 210 valid responses were collected, yielding an effective response rate of 90.52%. The specific items are presented in Table 2.

**Table 2** Variable Definition and Measurement

| Variable Type | Latent Variable | Number | Item |
|---|---|---|---|
| Explained variable | Innovative literacy of college students | IC1 | I can independently identify issues in learning and practice and propose solutions. |
| | | IC2 | I possess the fundamental capability to translate innovative ideas into practical solutions or outcomes. |
| | | IC3 | In team collaboration, I can work effectively with others to accomplish innovative tasks while fulfilling my designated role. |
| | | IC4 | I am able to summarize and reflect on my innovative attempts for continuous improvement. |
| | | IC5 | I can integrate professional knowledge to conduct interdisciplinary innovative thinking and experimentation. |
| | | IC6 | I have essential research and data analysis skills that support the implementation of innovative projects. |
| | | IC7 | When encountering challenges in the innovation process, I maintain a proactive attitude and systematically seek viable solutions. |
| Mediating variable | Innovation self-efficacy | SE1 | I believe I possess the fundamental capabilities required to complete innovation projects. |
| | | SE2 | Even if an innovative attempt fails, I maintain the confidence to initiate new attempts. |
| | | SE3 | I can clearly recognize my own strengths and limitations in innovation. |
| | | SE4 | When facing innovation tasks, I trust my ability to coordinate teams to achieve objectives. |
| | | SE5 | I am confident in my capacity to master new skills necessary for innovation through systematic learning. |
| | | SE6 | Even when encountering setbacks, I retain faith in my capability to develop novel solutions. |
| Explanatory variable | College students' innovative consciousness | IF1 | I will actively track innovative cases and cutting-edge knowledge in my field. |
| | | IF2 | I am willing to explore new approaches and methodologies in my learning process. |
| | | IF3 | I dare to express ideas and perspectives that differ from others. |
| | | IF4 | I actively participate in diverse innovation activities and practical projects. |
| | | IF5 | I consistently maintain curiosity toward novel concepts and emerging ideas. |
| | | IF6 | I am willing to take on the risks that may arise during the innovation process. |
| | Faculty resources | TF1 | Instructors of specialized courses encourage students to propose innovative ideas and express diverse viewpoints. |
| | | TF2 | The instructors delivering the courses possess extensive practical experience in innovation and entrepreneurship, enabling them to offer practical guidance. |
| | | TF3 | Teachers will explain innovative knowledge through practical cases rather than simply imparting theories. |

| Variable Type | Latent Variable | Number | Item |
|---|---|---|---|
| | Institutional training mechanisms | TF4 | Teachers will guide students to participate in practical activities such as innovation competitions and scientific research projects. |
| | | TF5 | Interdisciplinary course instructors facilitate collaboration among students from different disciplines to exchange innovative ideas. |
| | | SF1 | Sufficient integration of innovative thinking and teaching of innovative methods into professional courses |
| | | SF2 | The content of innovation and entrepreneurship courses in university is practical and not limited to pure theoretical explanations. |
| | | SF3 | The institution provides students with an innovation practice platform. |
| | | SF4 | The university maintains a comprehensive guidance and support system for innovation and entrepreneurship competitions/projects. |
| | | SF5 | The institution offers interdisciplinary courses, facilitating the exchange of innovative ideas among students from different disciplines |
| | | SF6 | The university can provide practical support, including funding and venue spaces, for student innovation projects |
| | | SF7 | The institution organizes academic exchange activities such as lectures and forums related to innovation. |
| | National policies | SS1 | I am aware of the national and local policies related to college students' innovation and entrepreneurship. |
| | | SS2 | The university promptly publicizes and interprets policies concerning college students' innovation and entrepreneurship. |
| | | SS3 | The university maintains university-enterprise collaborations that provide students with internship or practical training opportunities for innovative practices. |
| | | SS4 | Society offers abundant platforms for college students to engage in innovation and entrepreneurship through exchange and learning activities. |
| | | SS5 | External mentors can provide professional guidance for students' innovative projects. |
| | | SS6 | The host city or region creates a favorable environment and provides adequate resources to support college students' innovation activities. |

## 3 EMPIRICAL TEST

### 3.1 Reliability Analysis

Reliability analysis was conducted using Cronbach's α coefficient as the evaluation metric, with data analyzed through SPSS for individual variables and the overall scale. As shown in Table 3, the overall scale demonstrated a Cronbach's α coefficient of 0.941, indicating extremely high internal consistency. All subscales exhibited Cronbach's α values exceeding 0.80, suggesting adequate reliability across all dimensions and supporting their use as valid measurement instruments for subsequent analyses.

**Table 3** Reliability Analysis Results

| Dimension | Number of Terms | Cronbach's Alpha |
|---|---|---|
| Individual factors | 6 | 0.876 |
| Innovative self-efficacy | 6 | 0.877 |
| Teacher guidance | 5 | 0.886 |
| Institution cultivation mechanism | 7 | 0.912 |
| Social support | 6 | 0.885 |
| Innovation literacy | 7 | 0.851 |
| Total scale | 37 | 0.941 |

### 3.2 Validity Analysis

#### *3.2.1 Exploratory factor analysis*

The construct validity of the scale was verified through Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity. As shown in Table 4, the KMO value was 0.915, with an approximate chi-square value of 4351.083 for Bartlett's test of sphericity, 666 degrees of freedom, and significance level $p=0.000<0.001$, indicating that the sample data were fully suitable for factor analysis. Principal component analysis was employed to extract common factors,

combined with the criterion of eigenvalues greater than 1. This process ultimately identified 6 core common factors, which cumulatively explained 63.332% of the total variance, effectively capturing most of the variation information in the scale. After orthogonal rotation using the Varimax method, all standardized factor loadings of individual items on their corresponding common factors fell within the range of 0.5-1, with no serious cross-loading issues observed. These findings demonstrate that the dimensional structure of the scale is reasonable and its construct validity is satisfactory.

**Table 4** KMO Measure and Bartlett's Test of Sphericity

| KMO and Bartlett's test | | |
|---|---|---|
| KMO measure of sampling adequacy | | |
| Bartlett sphericity test | Approximate chi-square | 4351.083 |
| | Degrees of freedom | 666 |
| | Significance | 0.000 |

### *3.2.2 Confirmatory factor analysis*

Convergent validity was assessed through composite reliability (CR) and average variance extracted (AVE). As shown in Table 5: The CR values for college students' innovation awareness, faculty resources, institutional training mechanisms, national policies, and innovative self-efficacy all exceeded 0.7, while their corresponding AVE values surpassed 0.5, meeting the criteria for convergent validity. The CR value for college students' innovation literacy reached 0.851, satisfying internal consistency requirements. Although its AVE value (0.451) fell slightly below 0.5, it remained above the minimum acceptable threshold of 0.36 [3]. Given that the item content aligned with the conceptual definition, this construct was retained. Overall, both the scale's convergent validity and composite reliability fulfilled the requirements for empirical research.

**Table 5** Convergent Validity and Construct Reliability Testing Across Dimensions

| Item | Action Path | Average Variance Extracted(AVE) | Composite Reliability(CR) |
|---|---|---|---|
| IF1-IF6 | College students' innovative consciousness | 0.543 | 0.877 |
| TF1-TF5 | Faculty resources | 0.610 | 0.887 |
| SF1-SF7 | Institutional training mechanisms | 0.592 | 0.912 |
| SS1-SS6 | National policies | 0.563 | 0.886 |
| IC1-IC7 | innovative literacy of college students | 0.451 | 0.851 |
| SE1-SE6 | Innovation self-efficacy | 0.549 | 0.895 |

## 4 STRUCTURAL EQUATION MODELING AND HYPOTHESIS TESTING

### 4.1 Model Construction and Goodness-of-Fit Test

The initial structural equation model was constructed using Amos 28.0 software (as shown in Figure 1). Valid sample data were imported into the software. The overall model fit was first evaluated, with various indices summarized in Table 6. All goodness-of-fit indices for the initial model met the acceptable criteria, among which core fit indices including RMSEA, $\chi^2$/df, CFI, TLI, and IFI reached excellent levels, indicating a good model-data fit.

**Table 6** Fitness Test

| Goodness-of-Fit Test Statistic Name | Fitting Criteria | Test Results | Acceptability |
|---|---|---|---|
| GFI | >0.8 | 0.851 | Accept |
| AGFI | >0.8 | 0.830 | Accept |
| RMSEA | <0.08 | 0.032 | Accept |
| NFI | >0.8 | 0.840 | Accept |
| IFI | >0.8 | 0.968 | Accept |
| CFI | >0.8 | 0.967 | Accept |
| TLI | >0.8 | 0.965 | Accept |
| $\chi^2$/df | <3 | 1.213 | Accept |
| PGFI | >0.5 | 0.744 | Accept |

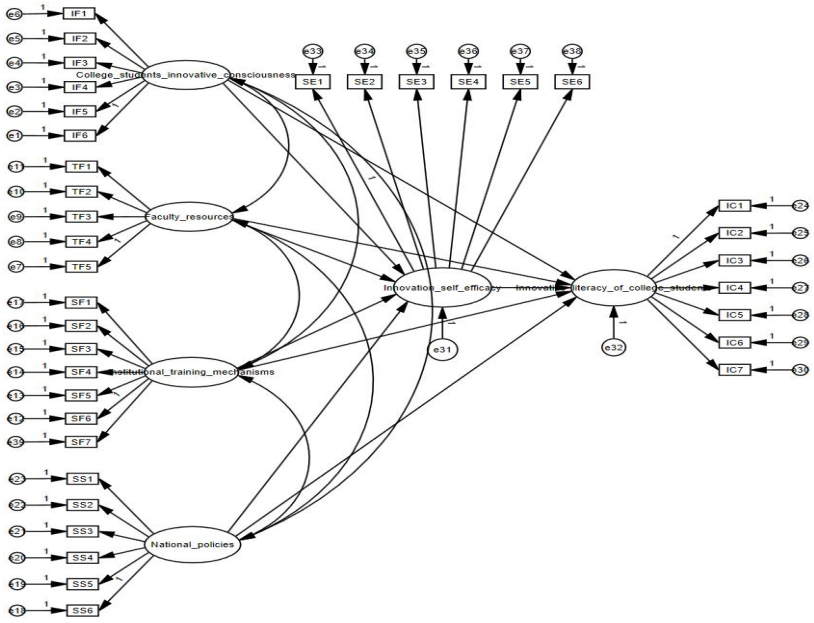


**Figure 1** Initial Model Path Diagram

### 4.2 Hypothesis Test Results

#### *4.2.1 Direct effect hypothesis testing*

According to Table 7, the following results were obtained:

(1) University students' innovative awareness, faculty resources, institutional training mechanisms, and national policies all demonstrate significant positive direct correlations with students' innovative literacy. The path coefficients in descending order are: university students' innovative awareness ($\beta$=0.304), national policies ($\beta$=0.179), institutional training mechanisms ($\beta$=0.167), and faculty resources ($\beta$=0.142), among which university students' innovative awareness constitutes the core intrinsic factor affecting innovative literacy.

(2) University students' innovative awareness, faculty resources, institutional training mechanisms, and national policies all exhibit significant positive direct impacts on innovative self-efficacy. The path coefficients in descending order are identical to the aforementioned values: university students' innovative awareness ($\beta$=0.215), institutional training mechanisms ($\beta$=0.187), national policies ($\beta$=0.185), and faculty resources ($\beta$=0.142), where student innovative awareness remains the core intrinsic determinant of innovative literacy.

(3) Innovative self-efficacy shows a significant positive direct association with university students' innovative literacy, thereby providing a foundation for the existence of a mediating effect.

**Table 7** SEM Relationship Test Result

| Hypothesis Number | Hypothesis Content | | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| $H_5$ | Innovation self-efficacy | College students' innovative consciousness | 0.215 | 0.079 | 2.743 | 0.006 |
| $H_6$ | Innovation self-efficacy | Faculty resources | 0.144 | 0.063 | 2.27 | 0.023 |
| $H_7$ | Innovation self-efficacy | Institutional training mechanisms | 0.187 | 0.061 | 3.051 | 0.002 |
| $H_8$ | Innovation self-efficacy | National policies | 0.185 | 0.073 | 2.532 | 0.011 |
| $H_1$ | innovative literacy of college students | College students' innovative consciousness | 0.304 | 0.077 | 3.969 | *** |
| $H_9$ | innovative literacy of college students | Innovation self-efficacy | 0.194 | 0.082 | 2.374 | 0.018 |
| $H_2$ | innovative literacy of college students | Faculty resources | 0.142 | 0.059 | 2.424 | 0.015 |
| $H_3$ | innovative literacy of college students | Institutional training mechanisms | 0.167 | 0.058 | 2.892 | 0.004 |
| $H_4$ | innovative literacy of college students | National policies | 0.179 | 0.069 | 2.6 | 0.009 |

Note: *** indicates P < 0.001, representing an extremely high level of statistical significance.

#### *4.2.2 Hypothesis testing of mediation effect*

Using the stepwise testing method proposed by Wen Z L, et al. [8], and based on the premise of significant direct effects as previously established, the analysis found that after incorporating the mediating variable, the direct effect of the independent variable on the dependent variable remained significant but showed a reduced coefficient. Therefore,

Hypothesis $H_{10}$ was supported. Innovative self-efficacy partially mediated the relationships between all four dimensions (including factors) and innovative literacy. This indicates that external environmental factors (including faculty resources, institutional training mechanisms, national policies) and internal individual factors (college students' innovation awareness) promote the development of innovative literacy partially through enhancing students' innovative self-confidence (including self-efficacy). The structural equation model path diagram generated using AMOS software is presented in Figure 2.

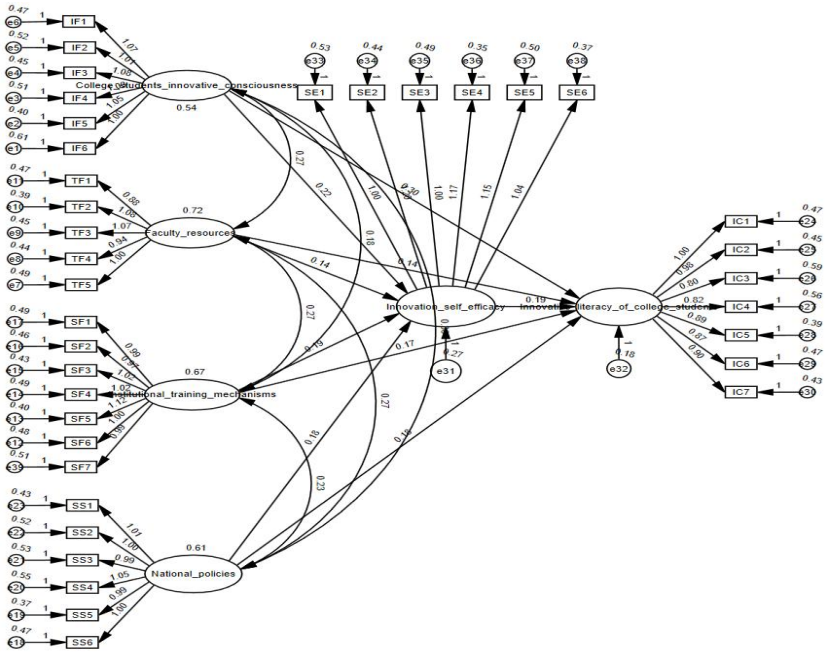


**Figure 2** Pathways of Influence for Each Dimension of University Students' Innovation Literacy

## 5 CONCLUSION OF THE STUDY

### 5.1 Core Research Conclusions

This study validated all 10 research hypotheses, with core conclusions including: First, four-dimensional factors - students' innovative awareness, faculty resources, institutional training mechanisms, and national policies - all demonstrate significant positive direct correlations with innovative literacy among private higher education institution students, among which students' innovative awareness exhibits the strongest influence intensity; Second, these four-dimensional factors also show significant positive associations with innovative self-efficacy, where students' innovative awareness and institutional training mechanisms constitute the core influencing factors for innovative self-efficacy; Third, innovative self-efficacy plays a significant partial mediating role in the relationships between various factors and innovative literacy, serving as a critical bridge transforming external empowerment into internal competence; Fourth, the innovative literacy of private higher education institution students results from synergistic effects across multiple dimensions, forming a hierarchical interrelationship characterized by "policy guidance → institutional implementation → faculty instruction → student practice".

### 5.2 Strategies for Cultivating Innovative Literacy among College Students in Private Higher Education Institutions in Guangdong Province

Based on empirical findings and combined with the institutional characteristics of private higher education institutions in Guangdong Province, core strategies are proposed from four dimensions: At the individual level, students should actively cultivate innovative awareness, engage in innovation practices, and accumulate successful experiences to enhance their self-efficacy in innovation. At the faculty development level, institutions should optimize teacher training programs and the recruitment system for dual-qualified faculty, while instructors need to integrate innovation education into specialized curricula, strengthen practical teaching approaches, and provide personalized guidance. At the institutional management level, universities should establish a rational innovation curriculum system, construct low-cost applied innovation practice platforms, and improve competition support mechanisms alongside resource allocation systems. At the social policy level, governments should establish targeted financial support for innovation and entrepreneurship education in private universities, develop regional innovation resource-sharing platforms, promote deep industry-academia collaboration, and foster synergistic education efforts through multi-stakeholder partnerships.

## COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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