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RESEARCH ARTICLE

Research on the Coupling Mechanism of Innovation and Entrepreneurship Education in Applied Universities

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ABSTRACT

This study explored the interaction between innovation and entrepreneurship education in applied universities and their impact on students' comprehensive abilities. Innovation and entrepreneurship education play a crucial role in the modern higher education system by fostering students' creativity and practical skills, thus contributing to socio-economic development. Through empirical research and structural equation modeling analysis, this paper aims to reveal the coupling mechanism and effects of innovation and entrepreneurship education. The research results indicate a significant positive relationship between innovation education and entrepreneurship education, and their effective combination can significantly enhance students' innovation and entrepreneurship abilities. Compared with previous studies that focused solely on innovation or entrepreneurship education, this study reveals the mutual promotion mechanism of the two, supplementing the theoretical knowledge about the coupling effect of education. Applied universities should focus on the integrated design of innovation and entrepreneurship education to enhance students' comprehensive abilities. This is not only significant for educators but also provides empirical evidence for policymakers to further promote higher education reform.By optimizing educational strategies, applied universities can better cultivate high-quality talents with innovative thinking and practical abilities for society.

INTRODUCTION

In the context of increasingly fierce global economic competition, innovation and entrepreneurship education has become an important part of higher education. As a key base for cultivating applied talents, applied universities need to closely integrate their educational models with social needs to enhance students' innovation abilities and entrepreneurial spirit(Jing, 2023; Al Balushi et al., 2023;Yu & Wang, 2022). In recent years, scholars at home and abroad have conducted extensive research on innovation education and entrepreneurship education, proving their significant role in cultivating students' creativity, practical skills, and overall quality(Huang, 2022;Miao, 2023;Jian et al., 2021). However, there is limited research on how to effectively combine the two to maximize educational outcomes.

Innovation education focuses on cultivating students' creative thinking and innovation abilities, stimulating their potential through course design, project practice, and academic research(Yu & Wang, 2022). Entrepreneurship education focuses on cultivating students' entrepreneurial awareness and abilities, helping students turn ideas into actual projects through entrepreneurship

courses, simulated business operations, and entrepreneurial incubators(Huang,2022) . Although their goals are different, they share the common aim of developing students' ability to face challenges. How to organically combine the two is an important direction for current educational research and reform.

Based on a review of existing literature and empirical research, this paper aims to explore the coupling mechanism of innovation and entrepreneurship education in applied universities. By designing questionnaires and constructing structural equation models, it investigates the interaction between innovation education and entrepreneurship education, as well as their impact on students' innovation and entrepreneurial abilities.

The research goal of this paper is to clarify the best combination of innovation and entrepreneurship education in applied universities to enhance students' overall abilities and promote the achievement of higher education talent cultivation goals. This paper aims to study the relationship between innovation education and entrepreneurship education, providing specific suggestions for optimizing educational strategies and serving as a reference for educators and policymakers.

1. LITERATURE REVIEW

The research history of innovation education can be traced back to the mid-20th century when scholars began to focus on creativity and its cultivation methods. Guilford (1950) proposed the concept of creativity, emphasizing its importance in education. Subsequently, Torrance (1966) further developed creativity tests, laying the foundation for empirical research in innovation education. In recent years, research on innovation education has focused more on practical applications, emphasizing the cultivation of students' innovative thinking and practical skills through project-based learning, interdisciplinary cooperation, and problem-oriented learning .

Regarding entrepreneurship education, since the 1980s, with the rapid development of the global economy and the rise of the entrepreneurial wave, entrepreneurship education has gradually become a focus of education in major universities. Kuratko and Hodgetts (2004) proposed the core elements of entrepreneurship education, including entrepreneurial knowledge, entrepreneurial skills, and entrepreneurial attitudes. Research indicates that systematic entrepreneurship education can not only enhance students' entrepreneurial intentions but also improve their ability to face challenges in actual entrepreneurial processes .

Regarding the coupling mechanism of innovation education and entrepreneurship education, the academic community has gradually formed a relatively consistent view. Pittaway and Cope (2007) proposed that innovation education and entrepreneurship education promote and complement each other; innovation education can provide a source of ideas for entrepreneurship education, while entrepreneurship education provides a practical platform for innovation education. Fayolle and Gailly (2008) further pointed out that the combination of the two can be achieved through integrated curriculum design, joint projects, and practical activities.

In China, with the implementation of the "Mass Entrepreneurship and Innovation" policy, innovation and entrepreneurship education have received unprecedented attention. The Ministry of Education has issued a series of documents requiring universities to strengthen the construction of innovation and entrepreneurship education systems and promote educational model reforms. As a key base for cultivating applied talents, applied universities' research on innovation and entrepreneurship education models has significant practical significance. Relevant scholars have found that applied universities have unique advantages in curriculum design, practical teaching, and university-enterprise cooperation, which can effectively promote the implementation of innovation and entrepreneurship education(Wang, 2023; Lv et al., 2022; Zhao, 2023)..

There are still some deficiencies in the research on the coupling mechanism of innovation education and entrepreneurship education. The main issues are: most existing research focuses on theoretical discussion and lacks systematic empirical analysis(Wang & Long, 2022; Zhou & Shi, 2021); a unified theoretical framework for the specific mechanism of their interaction has not yet been formed(Wang et al., 2022); and the specific models and effectiveness evaluation of applied universities in practical operations need further research and verification(Li, 2023; Ou, 2022).

The organic combination of innovation education and entrepreneurship education can significantly enhance students' overall quality and practical skills. By designing a scientifically reasonable curriculum system, strengthening practical teaching, and promoting university-enterprise cooperation, the effective coupling of the two can be achieved. The research on the coupling mechanism of innovation education and entrepreneurship education in applied universities has important academic value and practical significance at present.

2. RESEARCH METHODOLOGY

2.1 Data Collection and Descriptive Statistics

This study used a questionnaire survey method to collect and analyze questionnaires from students and teachers at three applied universities. A total of 400 questionnaires were distributed, and 380 valid questionnaires were recovered, with a recovery rate of 95%. Data collection was conducted using a combination of online and offline methods.

Table 1 : Primary and Secondary Indicators

Primary Indicators	*Secondary Indicators*
Innovation Education(IE)	Course Design(CD), Teaching Methods(TM), Practical Activities(PA)
Entrepreneurship Education(EE)	Entrepreneurship Courses(EC), Entrepreneurship Support(ES), Entrepreneurship Practice(EP)
Students' Innovation and Entrepreneurship Abilities(SA)	Innovation Ability(IA), Entrepreneurship Ability(EA), Comprehensive Ability(CA)

To ensure that the questionnaire design accurately reflects the research objectives, the questionnaire includes three primary indicators: Innovation Education(IE), Entrepreneurship Education(EE), and students' innovation and entrepreneurship abilities(SA). Each primary indicator is further divided into several secondary indicators. The questionnaire uses a five-point Likert scale, ranging from "strongly disagree" to "strongly agree," to facilitate respondents' rating of each question.

After completing the questionnaire design, a small-scale pre-survey was conducted. Based on respondents' feedback, the questionnaire was revised and refined to ensure the clarity of the questions and the comprehensibility of the questionnaire. For the formal survey, a random sampling method was used to randomly select students from three applied universities to complete the questionnaire. Random sampling ensures that the sample is representative and avoids sampling bias. The distribution and collection process of the questionnaires was strictly controlled to ensure the standardization and consistency of data collection.

After data collection was completed, the returned questionnaires were cleaned by removing incomplete or obviously unreasonable questionnaires to ensure the reliability and validity of the data.

To get a preliminary understanding of the overall situation of the sample, descriptive statistical analysis of the questionnaire data includes basic demographic characteristics, as well as the mean and standard deviation of each indicator.

2.2 Sample Information Statistics

As shown in Table 2, among the student respondents, the proportion of male respondents is 52.9%, and female respondents account for 47.1%. Among the teacher respondents, the gender ratio is 55% male and 45% female, indicating a relatively even gender distribution. The professional background of both student and teacher respondents is mainly in engineering. The distribution of student respondents is relatively even across freshmen, sophomores, and juniors, while the proportion of

senior respondents is relatively small. This is mainly because seniors are busy with job hunting and graduate school entrance exams, resulting in fewer students on campus.

Table 2：Sample Information Statistics

Sample category		*Student*		*Teacher*	
		Number of samples	*percentage（%）*	*Number of samples*	*percentage（%）*
Gender	Male	180	52.9	22	55
	Female	160	47.1	18	45
Professional Background	Science	90	26.5	11	27.7
	Engineering	197	57.9	23	57.5
	Literature	53	15.6	6	15
Grade	Freshman	102	30		
	Sophomore	98	28.5		
	Juniors	94	27.6		
	Senior	46	13.5		

2.3 Descriptive Statistics of Each Indicator

Among the three secondary indicators of innovation education, the average values of Course Design (CD), Teaching Methods (TM), and Practical Activities (PA) are 4.12, 4.08, and 4.25, respectively, all above 4.0, with standard deviations of 0.68, 0.71, and 0.64. This indicates that students generally rate the three secondary indicators of innovation education highly, with Practical Activities (PA) scoring the highest, showing that applied universities excel in providing innovation practice opportunities.

Among the three secondary indicators of entrepreneurship education, the average values of Entrepreneurship Courses (EC), Entrepreneurship Support (ES), and Entrepreneurship Practice (EP) are 4.05, 4.20, and 4.18, respectively, with standard deviations of 0.70, 0.65, and 0.67. This indicates that students also rate the three secondary indicators of entrepreneurship education highly, with Entrepreneurship Support (ES) and Entrepreneurship Practice (EP) scoring higher, showing that the school's efforts in providing entrepreneurship support and practice opportunities are recognized by the students.

Among the three secondary indicators of students' innovation and entrepreneurship abilities, the average values of Innovation Ability (IA), Entrepreneurship Ability (EB), and Comprehensive Ability (CA) are 4.22, 4.10, and 4.15, respectively, with standard deviations of 0.66, 0.69, and 0.68. Students rate their innovation and comprehensive abilities highly, indicating that innovation education and entrepreneurship education have played a positive role in enhancing students' overall abilities.

Table 3: Descriptive statistics

Primary Indicators	*Secondary Indicators*	*Average Value*	*Standard Deviation*	*Cronbach's Alpha*
IE	CD	4.12	0.68	0.82
	TM	4.08	0.71	0.85
	PA	4.25	0.64	0.80
EE	EC	4.05	0.7	0.83
	ES	4.2	0.65	0.86
	EP	4.18	0.67	0.81

SA	IA	4.22	0.66	0.84
	EA	4.1	0.69	0.82
	CA	4.15	0.68	0.83

2.4 Reliability and Validity Testing

Reliability Testing

To ensure the reliability of the questionnaire data, this study used Cronbach's Alpha coefficient to test the reliability of each indicator. Cronbach's Alpha coefficient is used to assess the consistency of items in the questionnaire and is an indicator of internal consistency. The results are shown in Table 3.

From the reliability test results, all secondary indicators have Cronbach's Alpha coefficients above 0.80, indicating high internal consistency and good reliability of the questionnaire. Among them, the Cronbach's Alpha coefficient for Teaching Methods (TM) is 0.85, and for Entrepreneurship Support (ES) is 0.86, showing the highest reliability, indicating strong consistency and stability in these aspects. The relatively lower reliability coefficients are for Practical Activities (PA) and Entrepreneurship Practice (EP), but they are still above 0.80, meeting the reliability requirements.

From the above results, it can be seen that the questionnaire designed in this study has high internal consistency, with all measurement indicators' Cronbach's Alpha coefficients exceeding the 0.80 standard. This indicates good consistency and reliability of the items in measuring the same indicators. It can be considered that the collected data is reliable and can provide a solid data foundation for subsequent statistical analysis and model construction.

Validity Testing

To ensure the validity of the questionnaire, this study uses Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) to test the construct validity of the questionnaire.

Exploratory Factor Analysis (EFA) evaluates data suitability through the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity, as shown in Table 4.

Table 4:Validity Test Statistics

Indicators	*KMO-Value*	*P-Value*
IE	0.85	＜0.001
EE	0.87	＜0.001
SA	0.86	＜0.001

The KMO values for innovation education, entrepreneurship education, and students' innovation and entrepreneurship abilities are all greater than 0.8, and Bartlett's test of sphericity is significant, indicating that the data is suitable for factor analysis. The results of the factor analysis show that each indicator converges well on its respective construct, verifying the construct validity of the questionnaire.

Confirmatory Factor Analysis (CFA) was conducted using AMOS software to evaluate the model's fit. The model fit indices include the chi-square test (χ^2), degrees of freedom (df), chi-square to degrees of freedom ratio (χ^2/df), Comparative Fit Index (CFI), Normed Fit Index (NFI), Incremental Fit Index (IFI), and Root Mean Square Error of Approximation (RMSEA). The results are shown in Table 5:

Table 5: Model Fit Results

Indicators	χ^2/df	*CFI*	*NFI*	*IFI*	*RMSEA*
Value	2.15	0.952	0.934	0.957	0.046

All fit indices meet the standards (χ^2/df < 3, CFI > 0.90, NFI > 0.90, IFI > 0.90, RMSEA < 0.05), indicating that the model fits well and confirming the validity of the questionnaire.

2.5 Correlation Analysis

To verify the relationship between Innovation Education(IE) and Entrepreneurship Education(EE), this paper uses Pearson correlation coefficients to analyze the correlation between each indicator. The correlation coefficient heatmap is shown in Figure 1, which displays the correlations between variables, with darker colors indicating stronger correlations.

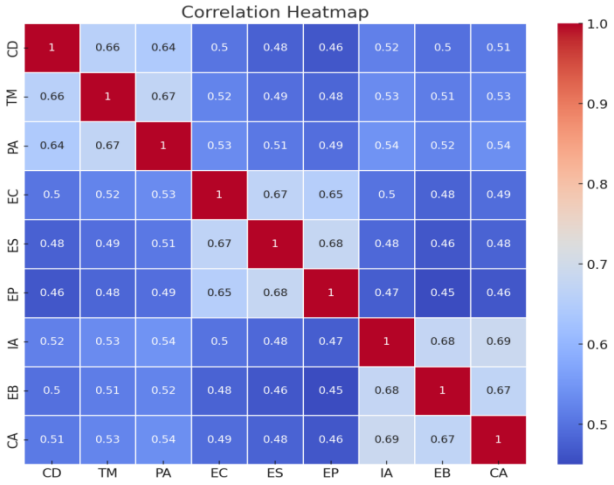

Figure 1:Correlation Coefficient Heatmap

There are significant positive correlations between the indicators of Innovation Education(IE) and Entrepreneurship Education(EE). The correlation coefficients between Course Design(CD), Teaching Methods(TM), Practical Activities(PA), and Entrepreneurship Courses(EC), Entrepreneurship Support(ES), and Entrepreneurship Practice(EP) range from 0.463 to 0.669, indicating a significant moderate positive correlation between Innovation Education(IE) and Entrepreneurship Education(EE). This suggests that good Innovation Education(IE) can promote the development of Entrepreneurship Education(EE), with both complementing each other to enhance Students' Innovation and Entrepreneurship Abilities(SA).

There are also high correlations between the internal indicators of Innovation Education(IE) and Entrepreneurship Education(EE). The correlation coefficients between Course Design(CD), Teaching Methods(TM), and Practical Activities(PA) in Innovation Education(IE) range from 0.643 to 0.672, and the correlation coefficients between Entrepreneurship Courses(EC), Entrepreneurship Support(ES), and Entrepreneurship Practice(EP) in Entrepreneurship Education range(EE) from 0.654 to 0.678. This indicates that the various aspects of Innovation Education(IE) and Entrepreneurship Education(EE) are interrelated, forming an effective overall education system.

The correlation coefficients between Students' Innovation and Entrepreneurship Abilities(SA) and the indicators of Innovation Education(IE) and Entrepreneurship Education(EE) range from 0.450 to 0.688, all of which are significantly positively correlated. The high correlations between students' Innovation Ability(IA), Entrepreneurship Ability(EA), Comprehensive Ability(CA), and the indicators of Innovation Education(IE) and Entrepreneurship Education(EE) further prove the significant role of Innovation Education(IE) and Entrepreneurship Education(EE) in enhancing Students' Innovation and Entrepreneurship Abilities(SA). Applied universities can effectively improve Students' Innovation and Entrepreneurship Abilities(SA) by optimizing Course Design(CD), Teaching Methods(TM), Practical Activities(PA), and providing systematic entrepreneurship courses and support mechanisms.

3. Data Structural Equation Modeling Analysis

3.1 Model Construction

To deeply explore the coupling mechanism of Innovation Iducation(IE) and Entrepreneurship Education(EE) and to verify their impact on Students' Innovation and Entrepreneurship Abilities(EA), this paper uses AMOS software to conduct Structural Equation Modeling (SEM) analysis. The model includes three latent variables: Innovation Education (IE), Entrepreneurship Education (EE), and

Students' Innovation and Entrepreneurship Abilities (SA). Each latent variable is measured by corresponding observed variables.

3.2 Analysis of Latent Variables in the Model

The path coefficients and significance test results of the latent variables in the structural equation model are shown in Table 6:

Table 6: Latent Variable Analysis Statistics

Path	*Standardized Path Coefficients*	*Standard Error*	*T-Value*	*P-Value*
IE → EE	0.52	0.07	7.43	<0.001
EE → IE	0.48	0.06	8	<0.001
IE → SA	0.58	0.08	7.25	<0.001
EE→ SA	0.55	0.07	7.86	<0.001

The standardized path coefficient of Innovation Education(IE) to Entrepreneurship Education(EE) is 0.52, with a significance p-value < 0.001, indicating that Innovation Education(IE) has a significant positive impact on Entrepreneurship Education(EE). This shows that systematic innovation course design, teaching methods, and practical activities can effectively stimulate students' entrepreneurial interest and abilities, promoting the development of Entrepreneurship Education(EE).

The standardized path coefficient of Entrepreneurship Education(EE) to Innovation Education(IE) is 0.48, with a significance p-value < 0.001, indicating that Entrepreneurship Education(EE) also has a significant positive impact on Innovation Education(IE). This means that systematic entrepreneurship courses and support mechanisms can provide students with abundant resources and platforms for their innovation activities, promoting the implementation of Innovation Education(IE).

There is a mutually reinforcing effect between Innovation Education(IE) and Entrepreneurship Education(EE), and their coupling can significantly enhance students' innovation and entrepreneurship abilities(SA). The standardized path coefficient of Innovation Education(IE) to Students' Innovation and Entrepreneurship Abilities(SA) is 0.58, with a significance p-value < 0.001, indicating that Innovation Education(IE) has a significant effect on enhancing Students' Innovation and Entrepreneurship Abilities(SA). Through systematic Innovation Education(IE), students can improve their innovative thinking and creativity, demonstrating higher abilities in entrepreneurial activities.

The standardized path coefficient of Entrepreneurship Education(EE) to Students' Innovation and Entrepreneurship Abilities(SA) is 0.55, with a significance p-value < 0.001, indicating that Entrepreneurship Education(EE) also has a significant effect on enhancing Students' Innovation and Entrepreneurship Abilities(SA). Through Entrepreneurship Education, students can acquire the necessary entrepreneurial knowledge and skills, improving their comprehensive abilities in actual entrepreneurial processes.

3.3 Analysis of Latent Variables and Observed Variables in the Model

To further understand the relationships between Innovation Education (IE), Entrepreneurship Education (EE), and Students' Innovation and Entrepreneurship Abilities (SA), this study further analyzed the latent variables and observed variables in the model. Table 7 shows the path coefficients of the observed variables for each latent variable and their significance test results.

Table 7:Latent Variable and Observed Variable Analysis Statistics

Latent Variables	*Observed Variable*	*Path Coefficients*	*Standard Error*	*T-Value*	*P-Value*

IE	CD	0.7	0.05	14	<0.001
	MT	0.68	0.05	13.6	<0.001
	PA	0.73	0.06	12.17	<0.001
EE	EC	0.75	0.06	12.5	<0.001
	ES	0.72	0.05	14.4	<0.001
	EP	0.76	0.06	12.67	<0.001
SA	IA	0.77	0.05	15.4	<0.001
	EA	0.74	0.05	14.8	<0.001
	CA	0.78	0.05	15.6	<0.001

Among the three observed variables of Innovation Education(IE), the path coefficients for Course Design (CD), Teaching Methods (TM), and Practical Activities (PA) are 0.70, 0.68, and 0.73, respectively, with significance p-values all less than 0.001. This indicates that the three observed variables of Innovation Education(IE) have a significant positive impact on innovation education (IE). The highest path coefficient for Practical Activities (PA) suggests that practical activities contribute the most to Innovation Education(IE).

Among the three observed variables of Entrepreneurship Education(EE), the path coefficients for Entrepreneurship Courses (EC), Entrepreneurship Support (ES), and Entrepreneurship Practice (EP) are 0.75, 0.72, and 0.76, respectively, with significance p-values all less than 0.001. This indicates that the three observed variables of Entrepreneurship Education(EE) have a significant positive impact on entrepreneurship education (EE). The highest path coefficient for Entrepreneurship Practice (EP) suggests that Entrepreneurship Practice(EP) contributes the most to Entrepreneurship Education(EE).

Among the three observed variables of Students' Innovation and Entrepreneurship Abilities(EA), the path coefficients for Innovation Ability (IA), Entrepreneurship Ability (EA), and Comprehensive Ability (CA) are 0.77, 0.74, and 0.78, respectively, with significance p-values all less than 0.001. This indicates that the three observed variables of Students' Innovation and Entrepreneurship Abilities(SA) have a significant positive impact on students' innovation and entrepreneurship abilities (SA). The highest path coefficient for Comprehensive Ability (CA) suggests that comprehensive ability contributes the most to Students' Innovation and Entrepreneurship Abilities(SA).

The observed variables of Innovation Education(IE) and Entrepreneurship Education(EE) all have a significant impact on their corresponding latent variables, validating the rationality of the questionnaire design and the effectiveness of the model construction. The observed variables have high explanatory power for their latent variables. Practical Activities (PA) and Entrepreneurship Practice (EP) play particularly significant roles in Innovation Education(IE) and Entrepreneurship Education(EE), respectively, while Comprehensive Ability (CA) contributes the most to Students' Innovation and Entrepreneurship Abilities(SA).

4. CONCLUSION

This study, through questionnaire surveys, reliability and validity tests, correlation analysis, and structural equation modeling, deeply explored the coupling mechanism of innovation education and entrepreneurship education in applied universities and their impact on students' innovation and entrepreneurship abilities. The research results show a significant positive relationship between innovation education and entrepreneurship education, where they mutually promote and complement each other. Innovation education, through course design, teaching methods, and practical activities, can effectively stimulate students' innovative thinking and creativity, thus providing a source of innovation for entrepreneurship education. Entrepreneurship education, through systematic course settings, entrepreneurial support, and practical opportunities, provides

the necessary resources and platforms for students' innovation activities, further promoting the implementation of innovation education.

The coupling degree of innovation education and entrepreneurship education has a significant impact on students' innovation and entrepreneurship abilities. Systematic innovation education can significantly enhance students' innovative thinking and creativity, while systematic entrepreneurship education can effectively improve students' entrepreneurial knowledge, skills, and attitudes. The organic combination of the two can improve students' overall quality and practical abilities.

This paper verified the interaction mechanism between innovation education and entrepreneurship education and revealed their impact on students' innovation and entrepreneurship abilities. It provides theoretical basis and empirical support for applied universities in designing and implementing innovation and entrepreneurship education systems. Applied universities should focus on the integrated design of innovation education and entrepreneurship education. Through a scientific curriculum system, rich practical activities, and effective support mechanisms, they can enhance students' innovation and entrepreneurship abilities, cultivating high-quality talents with innovative thinking and practical abilities.

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