

Empirical Data Analysis of Factors Influencing College Students' Entrepreneurial Ability in Hubei Province, China

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Abstract

This study aims to investigate the potential underlying mechanisms between entrepreneurial traits, entrepreneurial support, entrepreneurial education, entrepreneurial knowledge, and entrepreneurial capabilities of college students by using a comprehensive theoretical model. The survey data were collected from 309 college students participating in entrepreneurial activities in Hubei Province, China. Through empirical analysis methods, the collected data were tested using SPSS26.0 and AMOS24.0 software, and the mediating role of entrepreneurial support and the moderating role of entrepreneurial traits in the relationship were explored using linear regression equations. The results show that entrepreneurial support plays a mediating role between entrepreneurial support, entrepreneurial education, and entrepreneurial capabilities, and entrepreneurial traits have a moderating effect in this relationship. This study provides strong support for promoting the entrepreneurial capabilities of college students and discusses its theoretical and practical significance, as well as possible directions for future research.

Keywords: Data analysis, entrepreneurial support, entrepreneurial knowledge, entrepreneurial traits, entrepreneurial education, entrepreneurial ability.

1. Introduction

Currently, the difficulty of college students in finding employment has become a widespread social phenomenon. In particular, the employment mindset of contemporary college students, who are neither too high nor too low in their job expectations, and the employment pressure they face, seriously affect socio-economic development. Despite the national policies, such as "promoting employment through entrepreneurship," which have achieved certain effects in improving the entrepreneurial abilities of college students, there are still some problems. For example, the construction of entrepreneurial education faculty for college students is not perfect, the entrepreneurial theory system for college students is not sound, the entrepreneurial cultural atmosphere is not strong, and the support policies for college student entrepreneurship are not comprehensive, etc. These factors, to some extent, restrict the enhancement of contemporary college students' entrepreneurial abilities.

By leveraging data modeling and fitting techniques, we can accurately quantify the current status and bottlenecks of university students' entrepreneurial capabilities. Studies reveal that the proportion of university students engaging in entrepreneurship remains relatively low, with a correspondingly low success rate. A primary reason

for this lies in the inadequate entrepreneurial competencies of university students^[1]. Entrepreneurial ability of college students is the driving force that promotes their engagement in entrepreneurial activities^[2], and it is also a core indicator for measuring the quality of innovation and entrepreneurship education in colleges and universities. However, current research on the factors influencing college students' entrepreneurial ability is still limited. Existing research has either focused solely on external resource input factors^[3] or concentrated on localized influencing factors^[4], with a notable lack of attempts to consider university students' entrepreneurial capabilities as a multidimensional, multivariate system and utilize data fitting methods to explore its intrinsic composition and logical relationships. Consequently, employing advanced data simulation techniques in conjunction with empirical data analysis to delve into the multidimensional influencing factors and their interaction mechanisms of university students' entrepreneurial capabilities is not only an urgent practical necessity but also holds profound historical significance for driving educational innovation and economic development. Enhancing university students' entrepreneurial capabilities is not only an effective avenue to alleviate employment pressures and promote socio-economic growth but also a crucial aspect of individual growth and the construction of core competitiveness among university students. Through data simulation and fitting, we can more scientifically design entrepreneurship education curricula, optimize support policies, and foster a robust entrepreneurial culture, thereby effectively cultivating university students' entrepreneurial mindset, creative spirit, and entrepreneurial capabilities in practice, laying a solid foundation for achieving high-quality entrepreneurship. This study, grounded in this perspective, aims to provide solid theoretical and data-driven support for targeted and efficient enhancement strategies by deeply exploring the influencing factors and mechanisms of university students' entrepreneurial capabilities.

2. Literature Review

The investigation into entrepreneurial competence can be traced back to the 1960s. Entrepreneurial competence refers to an individual's or an organization's capability to undertake a novel task or create something unprecedented (Mitchelmore & Rowley, 2013)^[5]. Several Western scholars have attempted to delve into the essence and structural components of entrepreneurial competence through various lenses, including trait-based, opportunity-oriented, management-focused, and relational perspectives^[6]. Although consensus remains elusive, a significant proportion of researchers acknowledge entrepreneurial competence as a comprehensive capability^[7]. Consequently, conducting systematic research on the essence and structural elements of entrepreneurial competence from an integrated, multidimensional perspective has gradually emerged as the prevailing trend and mainstream of the field. March (1991) posits that entrepreneurial competence encompasses two primary facets: exploratory competence and exploitative competence^[8]. CHANDLER ET AL. (1993) further conceptualize entrepreneurial competence as an amalgamation of knowledge, abilities, and personal traits essential for entrepreneurs. They propose a theoretical model comprising six dimensions of entrepreneurial competence: opportunity competence, relational competence, conceptual competence, organizational competence, strategic competence, and commitment competence. This model has since become a seminal work, widely referenced and built upon by subsequent scholars examining entrepreneurial competence^[9]. MOSAKOWSKI (1997) posits that entrepreneurial competence comprises three dimensions: opportunity, relationship, and strategy^[10]. As another example, MORRIS ET AL. (2013) employed the Delphi method to identify 13 core entrepreneurial competencies, including opportunity recognition, opportunity evaluation, risk management or mitigation, vision articulation, resilience or perseverance, creative problem-solving, resource utilization, guerrilla capability, value creation through innovation, maintaining focus, flexibility, self-efficacy, and network building and utilization^[11]. In contrast, LANS ET AL. (2014) argue that entrepreneurial competence consists of five pillar elements: opportunity mastery, social competence, business competence, industry-specific competence, and entrepreneurial self-efficacy^[12].

Domestic research on entrepreneurial competence lags behind that of the West, with most researchers adopting a comprehensive, multi-dimensional perspective to explore its essence and structural elements, building upon and summarizing the work of Western scholars. TANG, for instance, has synthesized existing findings and proposed that entrepreneurial competence manifests in three dimensions: opportunity recognition, opportunity exploitation, and operational management^[13]. YIN AND ACI (2012) further developed a conceptual framework for

entrepreneurial competence that encompasses eight aspects: entrepreneurial traits, opportunity recognition ability, ideation capability, commitment ability, opportunity evaluation ability, opportunity utilization ability, and relationship capability^[14]. CHEN AND DAI (2013) view entrepreneurial competence as a centralized expression of an individual's comprehensive ability for all-round development. They constructed and effectively validated a graduate entrepreneurial competence model encompassing dimensions such as professional ability, collaboration skills, competitiveness, project management capability, and network information proficiency^[15]. Through research, ZHA (2015) revealed that the fundamental connotation of entrepreneurial competence among college students primarily comprises their creative, practical, and analytical comprehensive abilities, which are interdependent, mutually influential, and interactive^[16]. ZHONG ET AL. (2016), from the perspective of university students, argued that entrepreneurial competence encompasses abilities such as fund acquisition, management and decision-making, interpersonal relationships, and communication skills^[17]. ZHANG ET AL. (2017) classified entrepreneurial competence into two types: opportunity-related capabilities and managerial capabilities, further delineating these into six tertiary dimensions^[18]. WANG (2018) research concluded that college students' entrepreneurial competence encompasses capabilities in identifying and developing opportunities, acquiring resources and coordinating organizational capabilities, professional technical skills, as well as interpersonal relationship management^[19].

In summary, while there is a wealth of research on entrepreneurial competence conducted by scholars both domestically and internationally, few studies have specifically delved into the factors influencing the entrepreneurial competence of university students. Drawing upon the aforementioned literature and existing research findings, from an educational perspective, entrepreneurial competence among university students represents a conglomeration of knowledge, skills, and personality traits necessary for preparing for entrepreneurship, implementing ventures, and ensuring the sustainable development of such ventures^[20]. This competence is primarily influenced by entrepreneurial traits, entrepreneurial support, entrepreneurial education, and entrepreneurial knowledge. Consequently, this study constructs a moderated mediation model, with entrepreneurial support and entrepreneurial education as independent variables, entrepreneurial knowledge as a mediator, individual traits as a moderator, and entrepreneurial competence as the dependent variable. This model aims to explore the underlying mechanisms influencing university students' entrepreneurial competence, as illustrated in Figure 1. The primary objectives addressed are: (1) to investigate the mechanism through which entrepreneurial support and entrepreneurial education impact entrepreneurial competence via entrepreneurial knowledge; and (2) to explore how entrepreneurial traits moderate the effects of entrepreneurial support and entrepreneurial education on entrepreneurial knowledge.

3. Research Design

3.1 Data collection

This study focuses on college student entrepreneurs, with the sample primarily from Hubei province. Thirty representative universities within the province were selected, and the list of student entrepreneurs from each university was provided by the university's entrepreneurship institute or recruitment and placement office. Data collection and survey work were carried out using a combination of online and offline methods. Prior to the distribution of the questionnaires, detailed explanations regarding the objectives and details of the research were provided to guarantee that the feedback collected would be utilized exclusively for theoretical purposes. A total of 339 questionnaires were distributed, and after excluding those that were incomplete or showed obvious patterns, 283 valid questionnaires were obtained, resulting in a virtual response rate of 83.48%. Among them, 167 were male, accounting for 59%, and 116 were female, accounting for 41%; 42 were freshmen, representing 14.8%, 39 were sophomores, representing 13.8%, 101 were juniors, representing 35.3%, and 101 were seniors, representing 35.7%; 150 were from urban backgrounds, making up 53%, and 133 were from rural backgrounds, making up 47%; 142 students had relatives or friends with entrepreneurial experience, which is 50.2%, and 141 students did not have relatives or friends with entrepreneurial experience, which is 49.8%.

3.2 Variable measurement

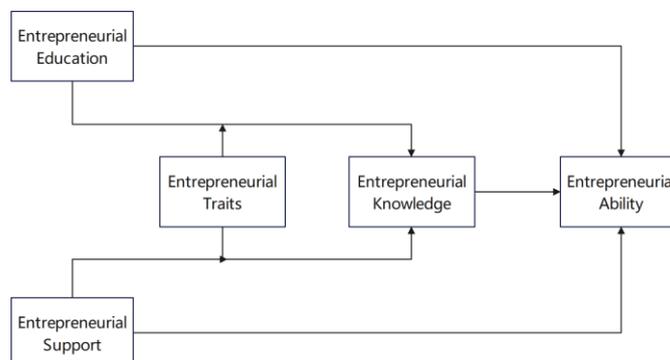


Figure 1 Structural model of the factors impressive entrepreneurial ability in college students

Table 1 Variables and items for measurement

Dimension	Item
Entrepreneurial Support	Parents or relatives are very friendly of entrepreneurship.
	Parents or relatives can afford a inevitable level of financial support.
	Parents or relatives can offer a certain amount of social connections.
	The city where I am has a strong entrepreneurial mood.
	Society widely encourages a spirit of innovation.
	The entrepreneurial environment in the city where I am has a good error tolerance technique.
	The government has provided effective preferential policies for college student entrepreneurship.
Entrepreneurial Knowledge	Acquired socially normative knowledge required for entrepreneurship.
	Acquired operational management knowledge such as marketing and finance.
	Acquired knowledge of resources such as funding and technology.
	Gained entrepreneurial experience from practice.
	Gained an understanding of various social norms and rules from practice.
	Captured new business opportunities from practice.
Entrepreneurial Education	I have taken many entrepreneurship courses.
	I frequently attend entrepreneurship lectures.
	I often self-study entrepreneurship-related books, biographies of famous people, and so on.
	Studying entrepreneurship courses has enabled me to accumulate essential entrepreneurial knowledge and skills.
	I often participate in entrepreneurship competitions (such as the "Challenge Cup," "Internet+" innovation etc.).
	I frequently participate in entrepreneurial activities (such as KAB and other entrepreneurship club events, startup project roadshows, etc.).
	Participating in entrepreneurship competitions and activities has allowed me to accumulate a significant amount of entrepreneurial knowledge.
	Participating in entrepreneurship competitions and activities has boosted my confidence in starting a business.
	The school has established platforms such as maker spaces and incubation centers for students, which has sparked a strong interest in entrepreneurship for me.
Entrepreneurial Ability	Able to identify unmet needs of consumers.
	Able to acquire the necessary resources during the business establishment process.
	Able to effectively manage employees and make appropriate decisions.
	I can effectively develop (or organize others to develop) new ideas.
	No matter what difficulties or setbacks I encounter, I will persevere.
	I can communicate effectively with different people in various environments.
	Possess good physical and mental quality.

Entrepreneurial	I have strong self-discipline and can manage myself effectively.
Traits	When expressing my emotions, I can often choose the appropriate vocabulary.

Entrepreneurial support is gauged using the Entrepreneurial Support Scale mature by YANG, which consists of 7 items^[21]; entrepreneurial knowledge is measured using the Entrepreneurial Knowledge Scale developed by XU, which consists of 6 items^[22]; entrepreneurial education is measured using the scale developed by ZHAO, which consists of 9 items^[23]; entrepreneurial ability is assessed utilizing the Entrepreneurial Ability Scale, which was developed by WANG, which consists of 6 items^[24]; personal traits are measured using the Individual Trait Scale developed by CHENG, which consists of 3 items^[25]. This study employs a 7-point Likert scale for the evaluation of the aforementioned variables, where the scale ranges from "1" for "not at all applicable" to "7" for "completely applicable," as seen in Table 1.

4. Results

4.1 Reliability, test for validity and common method bias

The deliverables of the confirmatory factor analysis as depicted in Table 2 indicate that the element loadings for each provision range from 0.75 to 0.95, and both Cronbach's α coefficient and composite reliability (CR) are above 0.9, indicating that the scales used in this research have high dependability. The Average Variance Extracted (AVE) values all exceed 0.7, which implies that the variables exhibit a high degree of convergent validity. The square mothers of the AVE values surpass the Pearson associations coefficients among the latent variables, which signals that the scales employed in this study possess robust discriminant validity. This demonstrates that the latent variables in the measurement shape of this study meet the assessment criteria proposed by Fornell and Larcker, and therefore, the pattern data is suitable as the empirical research basis for this study.

Table 2 Reliability and validity test

Latent Variable	Number of Items	Factor Loadings	Cronbach's α	Composite Reliability (CR)	Convergent Validity (AVE)	Discriminant Validity				
						1	2	3	4	5
Entrepreneurial Education	9	0.931-0.958	0.987	0.9874	0.8969	0.9470				
Entrepreneurial Support	7	0.893-0.933	0.974	0.9742	0.8434	0.793***	0.9184			
Entrepreneurial Knowledge	6	0.874-0.886	0.952	0.9524	0.7694	0.922***	0.907***	0.8772		
Entrepreneurial Ability	6	0.819-0.896	0.938	0.9391	0.7200	0.787***	0.837***	0.832***	0.8485	
Entrepreneurial Traits	3	0.852-0.905	0.916	0.9168	0.7862	0.674***	0.776***	0.860***	0.749***	0.8867

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, all are two-tailed; bolded values are the square roots of AVE for latent variables; the values positioned below the diagonal line represent the Pearson correlation coefficients.

This study employs Amos 24.0 for established factor analysis to test the discriminant availability of variables, with results shown in Table 3. It can be observed that the five-factor model has the best fit indices ($\chi^2/df=1.273$, SRMR=0.0193, RMSEA=0.031, CFI=0.991, TLI=0.990), which notably surpasses other models, demonstrating a strong discriminant validity among the variables. Additionally, the one-factor model has a very poor fit ($\chi^2/df=6.721$, SRMR=0.0640, RMSEA=0.142, CFI=0.807, TLI=0.794), proposing that mutual method bias is not a serious issue.

Table 3 Confirmatory factor analysis

Model	χ^2	df	χ^2/df	SRMR	RMSEA	CFI	TLI
Five-Factor Model	539.958	424	1.273	0.0193	0.031	0.991	0.990
Four-Factor Model ^a	1955.21	428	4.568	0.066	0.112	0.881	0.871
Three-Factor Model ^b	2399.277	431	5.567	0.0721	0.127	0.847	0.835
Two-Factor Model ^c	2612.927	433	6.034	0.0752	0.134	0.831	0.818

Single-Factor Model ^d	2916.873	434	6.721	0.0640	0.142	0.807	0.794
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Note: a indexes the combination of entrepreneurial support and entrepreneurial education; b indicates the combination of entrepreneurial support with entrepreneurial education, and the merging of entrepreneurial knowledge with entrepreneurial traits; c indicates the combination of entrepreneurial support with entrepreneurial education, and the merging of entrepreneurial knowledge, entrepreneurial traits, and entrepreneurial ability; d indicates the merging of all variables into a single factor.

4.2 Direct effects analysis

Table 4 illustrates that, based on the findings from Model 2, there is a remarkable positive impact of entrepreneurial support on the acquisition of entrepreneurial knowledge. ($\beta=1.018$, $p<0.001$). According to the results of Model 3, Additionally, entrepreneurial education is shown to exert a substantial positive influence on the development of entrepreneurial knowledge ($\beta=0.907$, $p<0.001$). According to the results of Model 5, entrepreneurial support has a significant active effect on entrepreneurial ability ($\beta=0.850$, $p<0.001$). According to the results of Model 6, entrepreneurial education has a significant positive effect on entrepreneurial ability ($\beta=0.711$, $p<0.001$). According to the results of Model 7, entrepreneurial knowledge has a significant positive effect on entrepreneurial ability ($\beta=0.761$, $p<0.001$).

Table 4 Direct effects analysis

Variable	Dependent Variable: Entrepreneurial Knowledge			Dependent Variable: Entrepreneurial Ability					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Constant	4.821***	-0.716**	0.577*	5.085**	0.461	1.757**	1.415**	0.738*	1.391**
Gender	0.017	0.092	0.002	-0.039	0.023	-0.051	-0.052	-0.012	-0.052
Grade Level	0.192*	0.151***	-0.031	0.06	0.026	-0.114*	0.086*	-0.032	-0.095*
Environment	-0.067	0.049	-0.079	0.131	0.228*	0.122	0.182*	0.209*	0.172*
Entrepreneurship	-0.234	-0.103	0.108	-0.177	-0.067	0.092	0.002	-0.027	0.023
Entrepreneurial Support		1.018***			0.850**			0.456**	
Entrepreneurial Education			0.907***			0.711**			0.136
Entrepreneurial Knowledge							0.761**	0.387**	0.634**

Note: * $p<0.05$, ** $p<0.01$, *** $p<0.001$, all are two-tailed.

4.3 Mediation effect analysis

After the inclusion of entrepreneurial knowledge, the consequences from Model 8 and Model 5 in Table 4 forecast that entrepreneurial support continues to have a positive impact on entrepreneurial ability ($\beta=0.456$, $p<0.001$). However, the recovery coefficient decreases from 0.850 to 0.456, showing a significant reduction in the effect, which suggests that entrepreneurial knowledge plays a regional mediating role between entrepreneurial support and entrepreneurial ability. According to the results of Model 9 and Model 6 in Table 4, entrepreneurial education does not have a valid impact on entrepreneurial ability ($\beta=0.136$, $p>0.05$), indicating that entrepreneurial knowledge fully mediates the relationship between entrepreneurial education and entrepreneurial ability. To further verify the mediation effect, a Bootstrap resampling analysis was conducted using Model 4 of the Process procedure in SPSS 24.0, as shown in Table 5. After controlling for gender, grade, environment, and post-entrepreneurial factors, the total effect of entrepreneurial support on entrepreneurial ability is 0.8502 (with a 95% confidence interval of [0.7852, 0.9151]), the indirect effect is 0.3944 (with a 95%

confidence interval of [0.2547, 0.5452]), and the direct effect is 0.4557 (with a 95% confidence interval of [0.3041, 0.6074]). The proportion of the indirect effect is 46.39%, and the proportion of the direct effect is 53.61%. The mediating effect of entrepreneurial education on entrepreneurial ability is 0.5752.

Table 5 Mediation effect analysis

Path Relationship	Path Effect	Effect Size	BootSE	Boot95%CI	
				Low	High
Entrepreneurial Support - Entrepreneurial Knowledge - Entrepreneurial Ability	Total Effect	0.8502	0.033	0.7852	0.9151
	Indirect Effect	0.3944	0.0743	0.2547	0.5452
	Direct Effect	0.4557	0.077	0.3041	0.6074
Entrepreneurial Education - Entrepreneurial Knowledge - Entrepreneurial Ability	Total Effect	0.7112	0.0327	0.6469	0.7755
	Indirect Effect	0.5752	0.0866	0.3932	0.7296
	Direct Effect	0.1360	0.0748	-0.0113	0.2833

Note: Bootstrap method with 5,000 resamples.

4.4 Moderation effect analysis

According to the results of Model 1 in Table 6, the reciprocity term between entrepreneurial support and entrepreneurial traits has a significant positive effect on entrepreneurial bricolage ($\beta=0.0623$, $p<0.001$), where entrepreneurial traits positively moderate the impact of entrepreneurial support on entrepreneurial knowledge. Based on the results of Model 2, the interaction term between entrepreneurial education and entrepreneurial traits significantly positively affects entrepreneurial knowledge ($\beta=0.0334$, $p<0.001$), with entrepreneurial traits positively moderating the influence of entrepreneurial education on entrepreneurial ability.

Table 6 Moderation effect analysis

Variable	Dependent variable: entrepreneurial knowledge	
	Model 1	Model 2
Constant	-0.1827	-0.0221
Gender	0.0422	-0.0214
Grade Level	0.1382***	0.0314
Environment	0.0145	-0.0889**
Entrepreneurship	-0.169***	-0.0501
Entrepreneurial Support	0.3985***	
Entrepreneurial Education		0.4348***
Entrepreneurial Traits	0.2265***	0.4115***
Entrepreneurial Support * Entrepreneurial Traits	0.0623***	
Entrepreneurial Education * Entrepreneurial Traits		0.0334***

Note: * $p<0.05$, ** $p<0.01$, *** $p<0.001$, all are two-tailed.

To clearly present the moderating effect of entrepreneurial traits, this study delineates the moderation effect diagrams by contrasting scenarios that are one criterion differences above and below the mean value of entrepreneurial attitudes, as given in Figures 2 and 3. From Figure 2, it can be seen that when entrepreneurial traits are low, the positive impact of entrepreneurial support on entrepreneurial knowledge is weak; when entrepreneurial traits are senior, the positive impact of entrepreneurial support on entrepreneurial knowledge is stronger. From Figure 3, it can be observed that when entrepreneurial traits are low, the positive effect of entrepreneurial education on entrepreneurial knowledge is weaker; when entrepreneurial traits are higher, the positive impact of entrepreneurial education on entrepreneurial knowledge is greater.

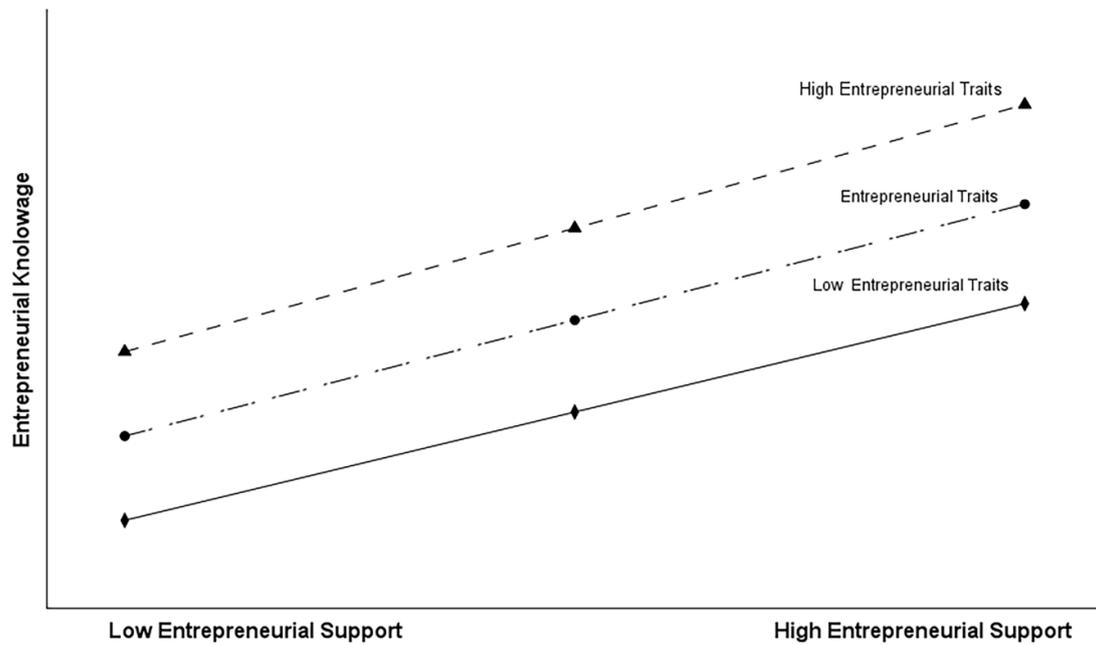


Figure 2 The moderating effect of entrepreneurial traits on the relationship between team support and entrepreneurial knowledge

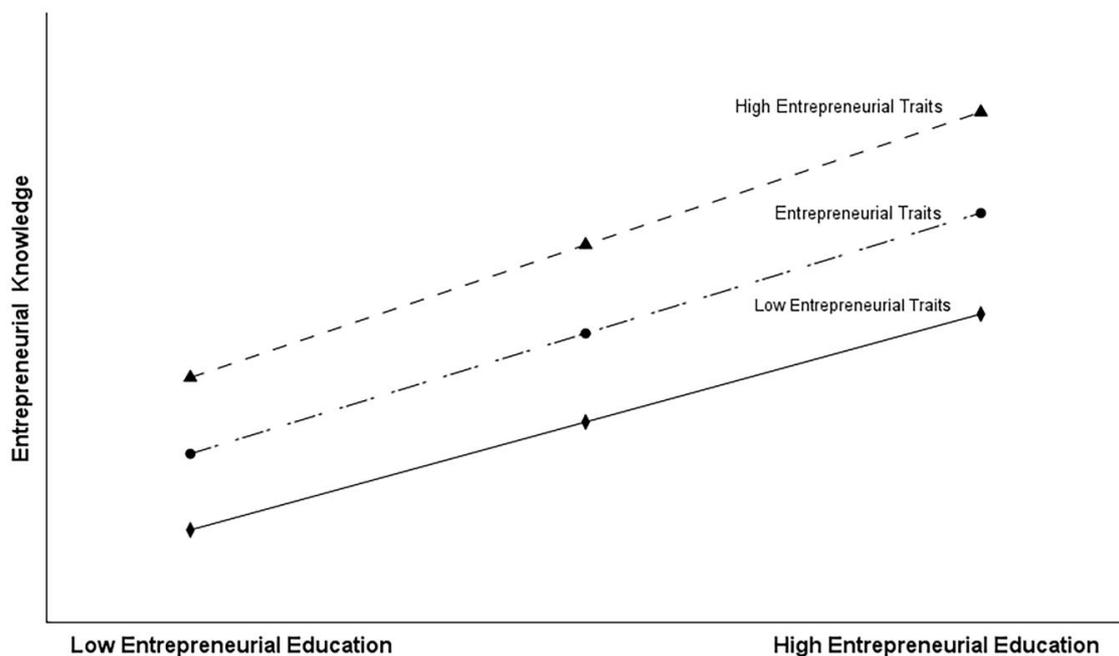


Figure 3 The moderating effect of entrepreneurial traits on the relationship between entrepreneurial education and entrepreneurial knowledge

4.5 Analysis of moderated mediation effects

This study further analyzes the modified mediation effect using Bootstrap resampling with Model 8 of the Process procedure in SPSS 24.0, as shown in Table 7. The Index indicator coefficient for the path "Entrepreneurial Support - Entrepreneurial Knowledge - Entrepreneurial Ability" in Table 7 is 0.023 (95% CI [0.0042, 0.0571]), challenging that entrepreneurial traits definitely moderate the impact of entrepreneurial support on entrepreneurial ability through entrepreneurial knowledge. The Index indicator coefficient for the path "Entrepreneurial Education - Entrepreneurial Knowledge - Entrepreneurial Ability" in Table 7 is 0.0155 (95% CI [0.0021, 0.0335]), indicating

that entrepreneurial traits also positively moderate the impact of entrepreneurial education on entrepreneurial ability through entrepreneurial knowledge. According to the results in Table 7, under normal levels of entrepreneurial traits, the mediating influence of entrepreneurial support on entrepreneurial ability through entrepreneurial knowledge is 0.2653 (95% CI [0.1023, 0.4818]); under low levels of entrepreneurial traits, the mediating infection of entrepreneurial support on entrepreneurial ability through entrepreneurial knowledge is 0.2380 (95% CI [0.0932, 0.4233]); and under high levels of entrepreneurial traits, the mediating affection of entrepreneurial support on entrepreneurial ability through entrepreneurial knowledge is 0.2927 (95% CI [0.1105, 0.5439]). This demonstrates that regardless of the magnitude of entrepreneurial traits, the mediating effect of entrepreneurial support on entrepreneurial ability through entrepreneurial learning is significant. Moreover, by comparing the mediating impression of entrepreneurial support on entrepreneurial ability through entrepreneurial knowledge at different levels of entrepreneurial traits, it is evident that the mediating effect is 0.0273 (95% CI [0.005, 0.068]) higher for high entrepreneurial traits compared to normal entrepreneurial traits, and for normal entrepreneurial traits compared to low entrepreneurial traits. This suggests that as entrepreneurial traits increase, their impact on how entrepreneurial support influences entrepreneurial ability through entrepreneurial knowledge also intensifies. Under normal entrepreneurial traits, the mediating effect of entrepreneurial education on entrepreneurial ability through entrepreneurial knowledge is 0.2819 (95% CI [0.0802, 0.4812]); under low entrepreneurial traits, the mediating effect of entrepreneurial support on entrepreneurial ability through entrepreneurial knowledge is 0.2635 (95% CI [0.075, 0.4515]); and under high entrepreneurial traits, the mediating effect of entrepreneurial support on entrepreneurial ability through entrepreneurial knowledge is 0.3004 (95% CI [0.0857, 0.5125]). This indicates that regardless of the level of entrepreneurial traits, the mediating effect of entrepreneurial education on entrepreneurial ability through entrepreneurial knowledge is significant. Additionally, by comparing the mediating affection of entrepreneurial education on entrepreneurial ability through entrepreneurial knowledge at different levels of entrepreneurial traits, it is found that for high entrepreneurial traits compared to normal entrepreneurial traits, and for normal entrepreneurial traits compared to low entrepreneurial traits, the mediating effect is 0.0185 (95% CI [0.025, 0.0398]) higher. This suggests that as entrepreneurial traits increase, their impact on how entrepreneurial education influences entrepreneurial ability through entrepreneurial knowledge also increases.

Table 7 Bootstrap analysis of moderated mediation effects

Moderated Mediation Effect	Moderating Variable	Effect Size	BootSE	Boot95%CI	
				Low	High
Entrepreneurial Support- Entrepreneurial Knowledge- Entrepreneurial Ability	Low Entrepreneurial Traits (M-1SD)	0.2380	0.0837	0.0932	0.4233
	Entrepreneurial Traits (M)	0.2653	0.0969	0.1023	0.4818
	High Entrepreneurial Traits (M+1SD)	0.2927	0.1111	0.1105	0.5439
	Entrepreneurial Traits - Low Entrepreneurial Traits	0.0273	0.0165	0.0050	0.068
	High Entrepreneurial Traits - Low Entrepreneurial Traits	0.0546	0.0330	0.0100	0.1359
	High Level of Entrepreneurial Traits - Entrepreneurial Traits	0.0273	0.0165	0.0050	0.0680
	Index	0.023	0.0138	0.0042	0.0571
Entrepreneurial Education- Entrepreneurial Knowledge- Entrepreneurial Ability	Low Entrepreneurial Traits (M-1SD)	0.2635	0.0956	0.0750	0.4515
	Entrepreneurial Traits (M)	0.2819	0.1017	0.0802	0.4812
	High Entrepreneurial Traits (M+1SD)	0.3004	0.1084	0.0857	0.5125
	Entrepreneurial Traits - Low Entrepreneurial Traits	0.0185	0.0095	0.0025	0.0398
	High Level of Entrepreneurial Traits - Low Entrepreneurial Traits	0.0369	0.019	0.0051	0.0797
	High Level of Entrepreneurial Traits - Entrepreneurial Traits	0.0185	0.0095	0.0025	0.0398
	Index	0.0155	0.008	0.0021	0.0335

Note: Bootstrap method with 5,000 resamples.

5. Conclusion

5.1 Research findings

Drawing upon a comprehensive retrospective survey dataset of 309 university entrepreneurs, this study employs data fitting techniques and statistical analysis methods to precisely construct a quantitative theoretical model examining the influencing factors of entrepreneurial capabilities. Through a meticulous data fitting process, we delve into the intricate mechanisms linking key variables such as entrepreneurial support, entrepreneurial knowledge, entrepreneurial traits, and entrepreneurial education with entrepreneurial capabilities. The specific conclusions are as follows:

(1) Entrepreneurial support and entrepreneurial education can directly promote entrepreneurial knowledge, and entrepreneurial knowledge can directly enhance entrepreneurial ability. (2) Entrepreneurial support can both directly enhance entrepreneurial ability and indirectly promote it through entrepreneurial knowledge, while entrepreneurial education can only facilitate entrepreneurial ability through entrepreneurial knowledge. (3) Entrepreneurial traits positively moderate the direct effects of entrepreneurial knowledge and entrepreneurial education on entrepreneurial knowledge, as well as the mediating effects of entrepreneurial support and entrepreneurial education on entrepreneurial ability.

5.2 Research strategies

Based on 309 retrospective survey data and the research findings of college student entrepreneurs in Hubei Province, this study proposes strategies for "improving support for college student entrepreneurship, strengthening college student entrepreneurial education, enhancing college student entrepreneurial knowledge, and cultivating college student entrepreneurial traits."

(1) In entrepreneurial activities, it is important to strengthen cooperation with external parties and enhance the utilization of external resources such as policies, information, and funding, ensuring that favorable external factors better serve college student entrepreneurship. To effectively enhance the entrepreneurial capabilities of college students, universities should increase their utilization of the external environment by seeking external resources and support. From a macro perspective, it is essential to establish mechanisms for a supportive social environment, creating a favorable national policy environment, an active industry support environment, and an encouraging entrepreneurial social culture. This should be achieved by providing strong support and promotion for entrepreneurial activities through various aspects such as policy, regulations, market, industry, information, and culture.

(2) Entrepreneurial education plays a valid role in the cultivation of entrepreneurial ability. To improve and strengthen entrepreneurial education in universities, it is necessary to design talent training programs based on the enlightenment of entrepreneurial ability, ensuring that the education is targeted and meets the needs of students. The integration of entrepreneurial education with professional education should be pursued, truly achieving the cultivation of entrepreneurial ability with a professional background. This approach fosters the development of comprehensive intellectual capabilities in all students.

(3) Strengthening the study of entrepreneurial knowledge is essential for enhancing entrepreneurial ability. There is a certain degree of compatibility between different learning methods and various types of entrepreneurial knowledge. Schools should select appropriate entrepreneurial learning methods to impart this knowledge. In terms of educational philosophy, it is important to establish and reinforce an outward-looking, open, and innovative concept of entrepreneurial education, focusing on improving students' learning capabilities. Comprehensive entrepreneurial education should be implemented, integrating entrepreneurial knowledge into the curriculum and incorporating it into regular course studies. In terms of educational content, innovate in course offerings and enhance practical education. Establish platforms that link on-campus and off-campus entrepreneurial learning to broaden the channels through which students can learn about entrepreneurship, allowing them to "experience" entrepreneurial practice and gain a genuine understanding of it. Strengthen the teaching and promotion of "simulated entrepreneurship" so that students can deeply analyze entrepreneurial opportunities and understand the

entrepreneurial process. Design support programs for college student entrepreneurship, organize entrepreneurship experts to help college students evaluate their entrepreneurial ideas, and provide timely entrepreneurial guidance by tracking entrepreneurial projects.

(4) In the process of cultivating college students' entrepreneurial abilities, enhancing entrepreneurial traits will comprehensively improve individual entrepreneurial capabilities. During the implementation of entrepreneurial education in universities, it is intentional to establish mechanisms for fostering personal entrepreneurial traits, cultivating creative personalities, stimulating creative behavioral motivations, and focusing on creative intelligence and abilities. It is important to strengthen entrepreneurial training and practical exercises for students with entrepreneurial potential or interest. On the foundation of universally inspiring innovation and entrepreneurial thinking in professional education, select groups of students with entrepreneurial potential for entrepreneurial practice training, which is more targeted and beneficial for enhancing students' entrepreneurial abilities. This approach also allows schools to focus resources on increasing entrepreneurial practice opportunities and strengthening support for student entrepreneurship, thereby effectively enhancing students' entrepreneurial capabilities.

5.3 Research limitations and prospects

Although this learning has achieved inevitable results in academic deduction and empirical verification, there are still boundaries. Firstly, the research only selected college students from Hubei as the research sample, which has a narrow scope and limited representatives. Future research should expand the geographical range of sample selection to fully consider the impact of regional heterogeneity in entrepreneurial resources. Secondly, the study obtained data and analyzed conclusions through questionnaires alone, which represents a singular research method. In the future, it would be beneficial to conduct more detailed research on college student entrepreneurs from universities of various levels across the country. Lastly, the study only surveyed college student entrepreneurs in Hubei, and the applicability of the research findings in other provinces and nationwide contexts requires further validation. Future research should conduct surveys on a broader scale to increase the universality of the conclusions.

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