Online-Journals.org

iJET International Journal of Emerging Technologies in Learning

iJET | eISSN: 1863-0383 | Vol. 18 No. 13 (2023) | OPEN ACCESS

https://doi.org/10.3991/ijet.v18i13.41907

PAPER

Coupling Correlation between the Support of Educational Environment and the Transformation of Students' Entrepreneurial Achievements

Lijun Wang, Liping Qu(✉), Shanshan Wang

Shijiazhuang University of Applied Technology, Shijiazhuang, China

2013010660@sjzpt.edu.cn

ABSTRACT

College students often lack entrepreneurial experience and business skills, which makes them face many difficulties in the process of starting a business, in such case, a supportive educational environment can play an important role, but current research pays little attention on the coupling correlation between the support of educational environment and the transformation of student entrepreneurs' achievements. In fact, a thorough understanding of this coupling correlation could provide effective support for colleges and policy makers to formulate educational policies and strategies, thereby increasing the success rate of student entrepreneurs. To fill in this research blank, this paper aims to study the coupling correlation between the support of educational environment and the transformation of student entrepreneurs' achievements. At first, a College Student Entrepreneurship (CSE) network under the support of educational environment was created, and the cooperation mode of student entrepreneurs under the support of educational environment was presented. Then, the transformation ability of student entrepreneurs' achievements was measured based on the Stochastic Block Model (SBM), a model for measuring the coupling between the support of educational environment and the transformation of student entrepreneurs' achievements was constructed, and the modeling steps were introduced in detail. At last, the validity of the proposed network and models was verified by experimental results.

KEYWORDS

support of educational environment, college student, entrepreneurship, achievement transformation, coupling correlation

1 INTRODUCTION

Globally, the entrepreneurship of college students has received much attention due to multiple reasons from two aspects. On the one hand, with the advancement of society and economy, enterprises' requirement for innovation and creation is surging,

Wang, L., Qu, L., Wang, S. (2023). Coupling Correlation between the Support of Educational Environment and the Transformation of Students' Entrepreneurial Achievements. *International Journal of Emerging Technologies in Learning (iJET)*, 18(13), pp. 137–151. https://doi.org/10.3991/ijet.v18i13.41907

Article submitted 2023-04-11. Resubmitted 2023-06-01. Final acceptance 2023-06-02. Final version published as submitted by the authors.

college students are a group of young people with new knowledge and fresh ideas, and their entrepreneurship exerts a great influence on socioeconomic progress [1–4]; on the other hand, for student entrepreneurs themselves, entrepreneurship is not only a job opportunity, but a good way to enhance their personal skills and increase their self-worth. However, in reality, the entrepreneurship success rate of college students is not high, and one important reason is their lack of business experiences and skills, so they have to face many obstacles during their business-running process, and how to increase their chance of success has become a concern of the society [5–9].

A supportive educational environment is quite important for college students' entrepreneurship. A good environment can provide the necessary knowledge, skills and guidance for student entrepreneurs and help them transform their achievements successfully [10–13]. However, current research pays little attention on the coupling correlation between the support of educational environment and the transformation of student entrepreneurs' achievements [14–18]. In fact, a thorough understanding of this coupling correlation could provide effective support for colleges and policy makers to formulate educational policies and strategies, thereby increasing the success rate of student entrepreneurs. Besides, this research can also help educators to improve entrepreneurship education and make it better fit the needs of student entrepreneurs.

Liu et al. [19] analyzed the necessity of building a transformation system for scientific and technological achievements based on the power grid of Yunnan. The authors pointed out this system should be built in accordance with the development features of state-owned enterprises and gave the specific implementation measures, the system contributes to increase the technical value of the property, reflect the value created by talents, and trigger the innovative spirit in employees. Cheng et al. [20] researched the influence of university–industry collaboration policy (UIC policy) on knowledge innovation and achievement transformation of universities through a measurement of policies issued at ministerial and provincial levels in China. Authors used the panel data of universities in 30 provinces from 2000 to 2013 to examine the influence of UIC policy on R&D input from two sources (input of enterprise–university collaboration and input of government–university collaboration), and on knowledge output and achievement transformation at different stages of the innovation chain. Their research results suggest that, the UIC policy has a significant positive effect on both collaboration modes, and there's an inverted U-shaped relationship between UIC policy and knowledge output/achievement transformation. For universities mainly engaging in enterprise–university collaboration, the UIC policy has a threshold effect on the interactive relationship between government–university collaboration input and enterprise–university collaboration input. Scholar Song [21] designed a platform for transforming innovation and entrepreneurship achievements based on PHP and a data center model. The data center with SSM model was employed to achieve efficient searching. To improve the security of network programs, relevant data such as password and user registration information should be encrypted in the development process of websites, and such operations could be adopted to improve the robustness of the system. Then the model performance was tested and verified through an analysis on the efficiency.

After carefully reviewing relevant literatures, it's found that the existing studies on the coupling of environmental support and achievement transformation have many shortcomings and defects. Some rely on self-reported data, such as questionnaires, which might be affected by bias or errors in memory or social expectation. Moreover, how to accurately measure the support of educational environment and the transformation of entrepreneurial achievements is also a great challenge, and most available research views it from a static point of view, ignoring that educational environment and entrepreneurial achievement might change dynamically, and

their relationship also involves over time. In view of these matters, this paper aims to study the coupling correlation between the support of educational environment and the transformation of student entrepreneurs' achievements.

2 CONSTRUCTION OF A CSE NETWORK UNDER THE SUPPORT OF EDUCATIONAL ENVIRONMENT

To figure out the entrepreneurship activities of student entrepreneurs under the support of educational environment, the influencing factors, and the coupling correlation between the support of the educational environment and the transformation of entrepreneurial achievements, at first, this study constructed a CSE network under the support of educational environment. This CSE network is a complex social network, in which the network nodes represent various participants and elements. Specifically, they include student entrepreneurs, teachers/mentors, entrepreneurship courses, entrepreneurship clubs/organizations, investors, and business/industry partners, etc. In this CSE network, the edges represent the relationships or interactions between nodes, specifically, they include the exchange of knowledge and information, the sharing and transfer of resources, and cooperative or competitive relations. The support of the educational environment may affect the formation and changes of nodes and edges in the network, thereby affecting the transformation of entrepreneurial achievements of college students.

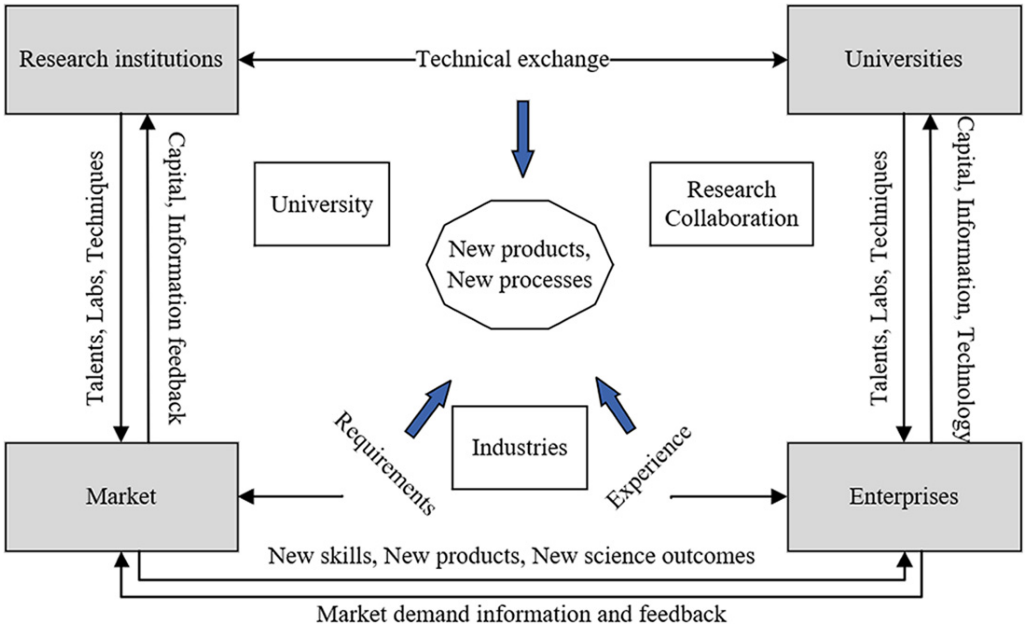

Fig. 1. CSE cooperation mode under the support of educational environment

Figure 1 gives a diagram showing the CSE cooperation mode under the support of educational environment. According to the figure, in the entrepreneurial process of college students, subjects supported by the educational environment include the higher education institutions, teachers/mentors, entrepreneurial guidance and consulting service institutions, student organizations, and government agencies, etc. The relationships among these subjects are collaborative and interactive. For example, higher education institutions can provide educational resources and platforms; teachers/mentors use these resources and platforms to teach; student organizations can organize activities; teachers and entrepreneurial guidance and consulting service

institutions can provide guidance for these activities; government agencies support the work of higher education institutions and other subjects through policies or funds. These collaborations and interactions can promote the development of entrepreneurship education for college students and increase the success rate of entrepreneurship.

Assuming: $G=\{g_1,g_2,...,g_m\}$ represents the node set; element G_n represents nodes in the CSE network; $D=\{d_{nm}\}$ represents the edge set, its elements are edges, representing the spatial interaction and connection of entrepreneurial activities between subjects supported by the educational environment, and each edge d_{nm} in D has a pair of nodes (G_n,G_m) corresponding to it; $F=\{f_1,f_2,...,f_i\}$ represents the set of entrepreneurial activities, elements in it represent the elements, information, and resources in the CSE network, and the size is equal to the intensity of entrepreneurial connection. The CSE network constructed in this study is used to reflect the entrepreneurial connection between network nodes.

$$C=(G,D,F) \tag{1}$$

The modified gravity model can well describe the mutual attraction between two bodies, it is also applicable to the CSE network, for instance, between student entrepreneurs, teachers, and resource providers, there are a certain degree of attractions, and the attraction force is determined by their "mass" (such as ability or resource) and "distance" (such as social or geographical distance). The modified gravity model can quantify these relationships, and provide a useful analysis tool for researchers.

The intensity of entrepreneurial connection of a network node directly affects the entrepreneurial performance of this network node. This study measured the entrepreneurial connection intensity of the CSE network based on the gravity model. For the entrepreneurial connection of nodes in the CSE network, assuming F_{nm} represents the entrepreneurial connection intensity between network nodes n and m; W_n and W_m represent the entrepreneurial scale of nodes n and m; G_{nm} represents the spatial distance between n and m; S represents the gravitational constant, then there is:

$$F_{nm}=S\frac{W_nW_m}{Q_{nm}^y} \tag{2}$$

Considering the non-equivalence nature of the spatial correlation of network nodes, the gravitational constant of the models needs to be corrected. Here, the gravitational constant is represented by the ratio of the entrepreneurial scale of a single network node to the sum of entrepreneurial scale of other network nodes that have an entrepreneurial connection with it, on this basis, a directional CSE network was built, and the modified gravity model is given by the following formula:

$$F_{nm}=\frac{W_n}{W_n+W_m}\frac{W_nW_m}{\sqrt{G_{nm}}} \tag{3}$$

Density, centrality, connection intensity and node difference are common indicators of social network analysis, they can reflect the characteristics of the CSE network from different angles.

Network density is the ratio of the number of edges that actually exist in the network to the number of edges that may exist in the network. In the CSE network, network density can reflect the degree of correlation between entrepreneurs, mentors, resource providers and other subjects. A higher network density usually indicates richer information exchange and resource sharing, which is conducive to entrepreneurship.

Assuming: *Den* represents the density of the CSE network; *I* represents the node number, *i* represents the number of actual connections in the network, then there is:

$$DEN = \frac{i}{I(I-1)} \tag{5}$$

Centrality refers to the centrality of a node in the network, which can be further divided into degree centrality, closeness centrality, and betweenness centrality. In the CSE network, centrality can be used to identify nodes that play a key role in the network. For example, a student entrepreneur with a higher degree of centrality may have more social connections and a greater possibility of getting richer entrepreneurial resources and information, the specific expression is:

$$DC_j = \frac{i(n)}{I-1} \tag{6}$$

The network connection intensity reflects the closeness degree of relationships between nodes in the network. In the CSE network, connection intensity may be related to factors such as interaction frequency and resource exchange volume between nodes, for instance, the guidance relationship between entrepreneurs and mentors, as well as the financial relationship between entrepreneurs and investors, can be measured by this connection intensity, and the specific expression is:

$$STH_n = \sum_m F_{nm} = \sum_m \frac{w_n}{w_n + w_m} \frac{w_n w_m}{\sqrt{Q_{nm}}} \tag{7}$$

Node difference refers to characteristic differences of different nodes in the network, such as the type and attribute of nodes. In the CSE network, node difference can reflect the diversity and complexity of the entrepreneurial environment, for instance, differences in the knowledge background and ability level of entrepreneurs can affect the methods and results of their entrepreneurship, and differences in the type and scale of resource providers can affect their support method and degree for the entrepreneurship of college students. Assuming: $z_{nm}=F_{nm}/\sum_m F_{nm}$ represents the size of weight, then there is:

$$DIS_n = \frac{(I-1)\sum_m \left(\frac{F_{nm}}{\sum_m F_{nm}} \right)^2 - 1}{I-2} \tag{8}$$

The development of Internet has a huge impact on the CSE network, especially in terms of information acquisition, resource connection, and market expansion, it has dramatically changed the methods and paths of entrepreneurship. In the meantime, the regional difference of Internet development may have different effects on the CSE network, for instance, a region with a highly developed Internet can provide richer online resources and a bigger market, which is beneficial for college students to start their own businesses. Incorporating the development level of Internet into the model can more comprehensively depict the various factors affecting the CSE network and enhance the interpretability of the model. So this paper took Internet development as an important influencing factor of the CSE network, and constructed a CSE network under the support of Internet and educational environment, and a panel data model of control variables. Assuming: *n* represents the region; *p* represents time;

$SPZBs_{n,p}$ represents the level indicator of node n in the CSE network during time period p, it contains three indicators, namely the centrality, connection intensity, and heterogeneity of node n in the CSE network during time period p; $SPZB_{n,p}$ represents the Internet development level indicator of node n during time period p; $KZBL_{n,p}$ represents the control variable; r_p represents the time-fixed effect; ω_n represents the effect of fixed network node; γ_{np} represents the random disturbance term, then the model expression is given by the following formula:

$$SPZBk_{n,p} = \alpha_1 SPZB_{n,p} + \alpha_2 KZBL_{n,p} + r_p + o_n + \gamma_{n,p} \tag{10}$$

3 MEASUREMENT OF COLLEGE STUDENTS' ABILITY TO TRANSFORM ENTREPRENEURIAL ACHIEVEMENTS

Figure 2 shows the stages of scientific and technological achievements transformation. According to the understanding of Figure 1, this paper measured the ability of college students to transform their entrepreneurial achievements based on SBM. The model assumes that nodes in a network can be divided into multiple "communities" or "blocks" and that the probability of connections within and between blocks is known. When measuring the said ability of college students, SBM has obvious advantages and its principle is plain to see. SBM can effectively identify the community structure in the network, which is particularly important for the CSE network, since entrepreneurs often need to seek for resources and support in certain communities or blocks. Assuming: ϑ_0^* represents the technological achievements transformation efficiency of decision-making unit DMU_0; $a_{n0}^c \in F^{jc}{}_+$ represents the input vector of network node c of DMU_0; network node c has j_c kinds of input under the entrepreneurial support; $B_{f0}^c \in F^{fc}{}_+$ represents the output vector of network node c under the entrepreneurial support; network node c has f_c kinds of output under the entrepreneurial support; g_{n0}^{c-} and g_{f0}^{c+} represent the slack variables of input and output; z^c represents the wight of network node c; $\eta^c \in F_i^+$ represents a non-negative vector; h represents a constant; $w_0^{(c,e)}$ represents the intermediate variable, then the expression of SBM is given by the following formula:

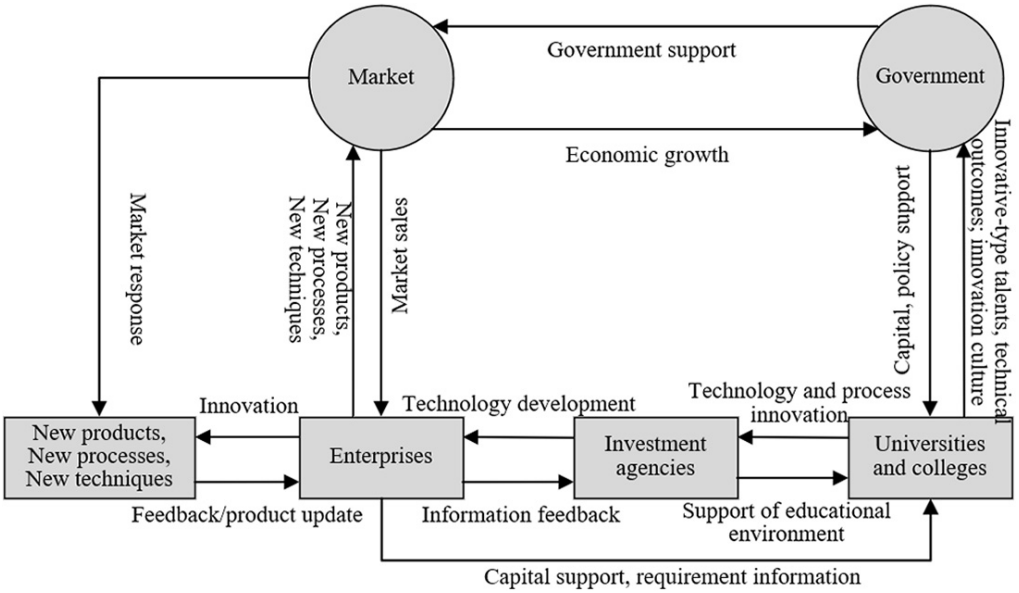

Fig. 2. Stages of transformation of scientific and technological achievements

$$MIN\ \vartheta_0^* = \frac{\sum_{c=1}^{C} z^c \left[1 - \frac{1}{j_c}\left(\sum_{n=1}^{j_c} \frac{g_{n0}^{c-}}{y_{n0}^c}\right)\right]}{\sum_{c=1}^{C} z^c \left[1 + \frac{1}{f_c}\left(\sum_{n=1}^{f_c} \frac{g_{f0}^{c+}}{x_{f0}^c}\right)\right]}\ g.p.\begin{cases} \sum_{c=1}^{C} z^c = 1, z^c \geq 0\ (\forall s) \\ a_0^c = A^c \eta^c + g_0^{c-}\ (c = 1,...,C) \\ b_0^c = B^c \eta^c - g_0^{c+}\ (c = 1,...,c) \\ h\eta^c = 1\ (c = 1,...,c) \\ g_0^{c+}, g_0^{c+}, \eta^c \geq 0\ (\forall c) \\ w_0^{(c,e)} = W^{(c,e)} \eta^e\ (\forall (c,e)) \\ w_0^{(c,e)} = W^{(c,e)} \eta^c\ (\forall (c,e)) \end{cases} \tag{11}$$

Assuming: g_{n0}^{c-*} and g_{f0}^{c+*} represent the slack variables of optimal input and output under entrepreneurial support; if $\vartheta_0^* = 1$, then it means DMU_0 is valid on the whole; if q_c=1, then it means network node c in DMU_0 is valid, the simulation flow is shown in Figure 3, and the formula below gives the efficiency of sub-DMUs:

$$\vartheta_0 = \frac{\sum_{c=1}^{C} 1 - \frac{1}{j_c}\left(\sum_{n=1}^{j_c} \frac{g_{n0}^{c-*}}{a_{n0}^c}\right)}{\sum_{c=1}^{c} 1 + \frac{1}{f_c}\left(\sum_{n=1}^{f_c} \frac{g_{f0}^{c+*}}{b_{f0}^c}\right)} (c = 1,...,C) \tag{12}$$

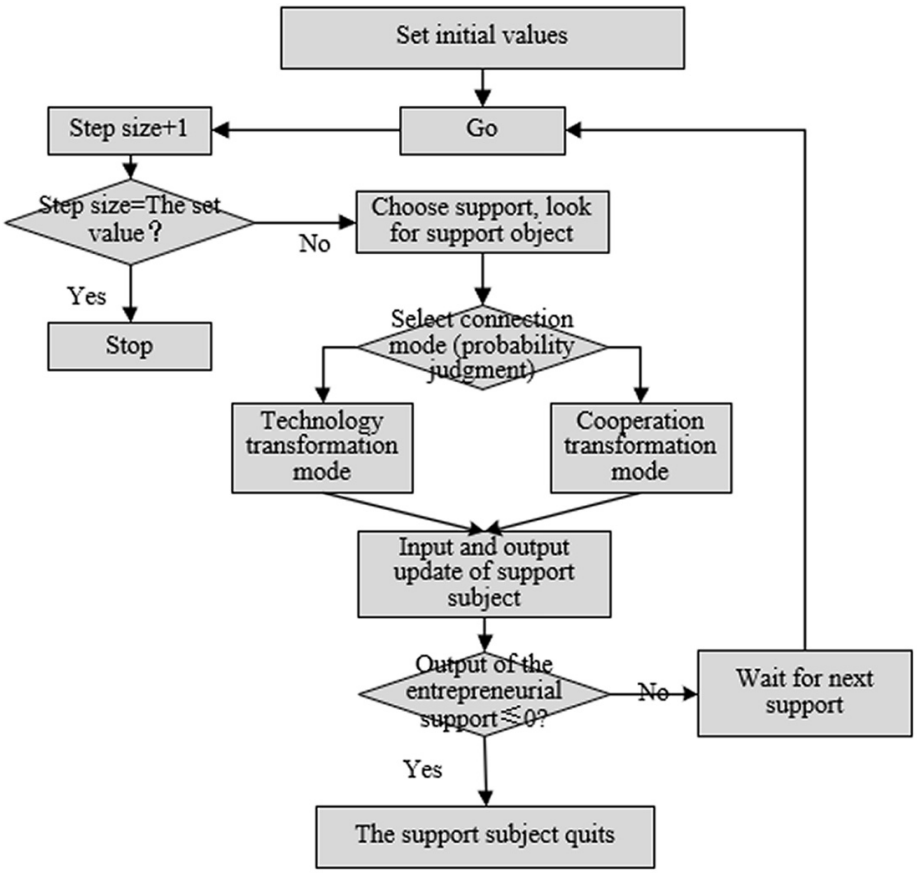

Fig. 3. Simulation flow

4 THE COUPLING MODEL OF SUPPORT OF EDUCATIONAL ENVIRONMENT AND TRANSFORMATION OF COLLEGE STUDENTS' ENTREPRENEURIAL ACHIEVEMENTS

The CSE network under the support of educational environment can be regarded as a complex system composed of several subsystems. These subsystems represent different elements and relationships, together they constitute the overall environment for college students' entrepreneurship. Specifically, there are five subsystems: education subsystem, community subsystem, resource subsystem, support service subsystem and policy subsystem. These subsystems affect each other and form the entire entrepreneurial environment. Understanding these subsystems and the relationships between them could help us better support student entrepreneurs to start their own businesses.

Theory of Synergetics focuses on interactions and collaborations between systems, with particular attention on the order parameters of the system, namely the key parameters that describe the state and behavior of each subsystem. During achievement transformation activities, the above-mentioned five subsystems can be regarded as mutually coupled systems, and the degree of coupling between them can be described by order parameters.

The construction of this coupling model can be divided into three steps:

In this study, the power function was adopted to measure the contribution of each indicator to the system, details are given below:

First, the power function of two systems was defined and calculated, namely the function for describing the efficiency of the systems, the five sub-systems were regarded as an entire composite system, and the comprehensive order parameter of the *in*-th (n=1,2,3) subsystem was set as the variable; assuming J_{nm} (n,m=1,2,3...) represents the m-th indicator of the n-th order parameter; O_{nm} represents the size of its contribution to the entire composite system; $MAX(J_{nm})\backslash MIN(J_{nm})$ represent the upper and lower limits of system parameters, then there is:

$$o_{nm} = \frac{J_{nm} - MIN(J_{nm})}{MAX(J_{nm}) - MIN(J_{nm}),}(n,m = 1,2,3...) \tag{13}$$

where, $O_{nm} \in [0,1]$. The total contribution of the five subsystems to the entire composite system can be attained by the linear weighting method, namely $O_n = \sum^i z_{nm} o_{nm}$, $\sum^i z_{nm} = 1$.

The support of educational environment is crucial for the transformation of entrepreneurial achievements of college students. By modeling the coupling between the two, we can better understand and reveal the specific influence method and degree of the support of educational environment on the transformation of student entrepreneurs' achievements, then targeted methods could be taken to optimize the educational environment, and the coupling degree here can be regarded as the intensity of the mutual influence between subsystems.

The synergic relationship between subsystems can be reflected by the coupling between three aspects: the mutual relationship (O_1) between the support of educational environment and the transformation of student entrepreneurs' achievements, the influence degree (O_2) of the support of educational environment on the transformation of student entrepreneurs' achievements, and the possible performance (O_3) of the transformation of student entrepreneurs' achievements under the support of educational environment:

$$G = [(O_1 \times O_2 \times O_3) / \prod(O_1 + O_2 + O_3)]^{1/3} \tag{14}$$

The coupling-coordinating model can help us understand the balance between the support of educational environment and the transformation of student entrepreneurs' achievements, and it provides important references for optimizing educational resource allocation and increasing the success rate of entrepreneurship. The coupling-coordinating degree here can be regarded as the balance and synergy state between two systems, and it can be measured by factors including the reasonable utilization of educational resources, the timely implementation of entrepreneurial activities, and the interaction effect between education and entrepreneurship.

To prevent the coupling-coordinating model from giving false evaluation results, this paper introduced a dynamic coupling-coordinating model. Assuming: Q represents the coupling-coordinating degree; G represents the coupling degree; P represents the comprehensive coordinating index and $P \in [0,1]$; x_1, x_2, x_3 represent the weight in the system, then the specific expression of the model is:

$$\begin{cases} Q = \sqrt{G * P} \\ P = \sqrt{x_1 O_1 + x_2 O_2 + x_3 O_3} \end{cases} \tag{15}$$

5 EXPERIMENTAL RESULTS AND ANALYSIS

Table 1. Descriptive statistics of variables

	Observed Number	Mean	Standard Deviation	Minimum	Maximum
Network Centrality	5,211	0.4396	0.3815	0	1
Network connection intensity	5,211	3544.948	5534.05	40.454	321565.5
Network heterogeneity	5,211	0.0012	0.00034	0.000154	0.00645
Internet development	5,211	–0.03154	1.2134	10455	21.1534
Output under entrepreneurial support	5,211	36844.74	30241.64	98	46.14654
Scientific expenditure	5,211	8344.145	5645.46	0.15645	462000
Educational expenditure	5,211	46515.21	751613.51	0.165154	1300000
Number of universities	4,103	62441	11.1321	3	84
Number of teachers	4,110	3941.641	74566.51	23	61213
Degree of openness	4,106	5341.152	2.11*e*+21	64651.4654	3.30*e*+08
Enterprises	5,216	0.851156	0.41562	0.134687	42.13
Other subjects	5,216	0.3333	0.4564	0	1

Table 1 gives a descriptive statistics on the variables of the CSE network, the data shows that the mean centrality is 0.4396, the standard deviation is 0.3815, and the range is between 0 and 1, these indicate that centrality distributes widely in this CSE network, some nodes are more important than others. The mean connection intensity is 3544.948, but the standard deviation reaches 5534.05, indicating that the distribution of connection intensity is quite uneven, the connection intensity of some nodes is very high. The mean heterogeneity is 0.012, the standard deviation is 0.00034, these results indicate that nodes in the CSE network are not that different. The mean value of Internet development is –0.03154, the standard deviation is 1.2134, the maximum value is 21.1534, and the minimum value is 10455, these

data indicates that there are significant differences in the level of Internet development between different regions. The average output of entrepreneurship support is 36844.74, the standard deviation is 30241.64, indicating obvious fluctuations in entrepreneurial achievements, and the success rate of entrepreneurship is affected by many factors. The two indicators of scientific expenditure and educational expenditure reflect the universities' input in scientific research and education, the data reveals significant differences between different regions, which has affected the formation and development of Internet in these regions. In terms of the number of universities, the number of teachers, the degree of openness, enterprises and other subjects: these indicators reflect the influence of educational environment, economic environment and social environment. The data also suggests significant differences in these aspects between different regions, and they also have important influence on the construction of the CSE network.

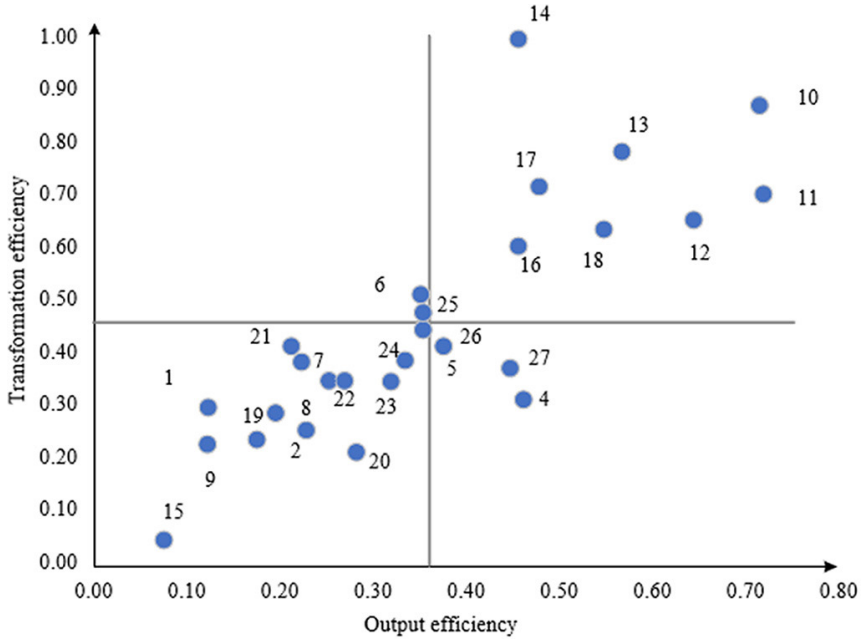

Fig. 4. Output of entrepreneurial support vs. achievement transformation efficiency

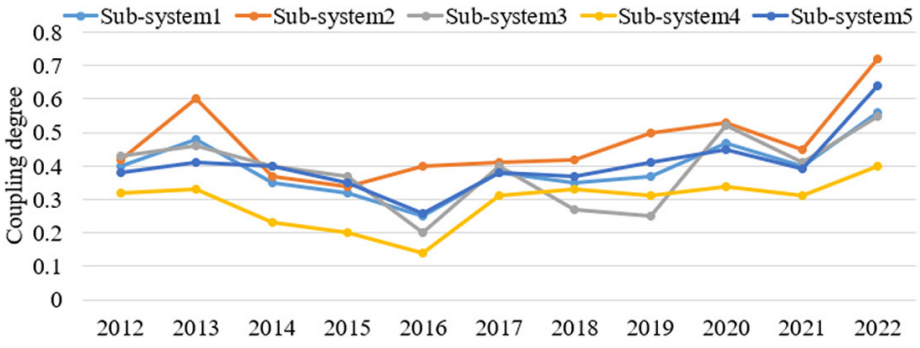

Fig. 5. Trend of coupling degree of different subsystems

For the relationship between the output of entrepreneurship support and achievement transformation efficiency, this paper divided it into four quadrants: 1) high output efficiency, high transformation efficiency; 2) high output efficiency, low

transformation efficiency; 3) low output efficiency, high transformation efficiency; 4) low output efficiency, low transformation efficiency. Figure 4 shows the relationship between the two based on the above four modes. The ideal state is that both the output efficiency and the transformation efficiency are high, but in reality, the situations need to be analyzed and improved according to different conditions. In any case, a supportive educational environment is crucial for the entrepreneurial activities of college students and it can effectively promote the generation and transformation of entrepreneurial achievements.

Combining with an example, Figure 5 plots the trend of coupling degree of different subsystems. Here is an analysis of the trend of five subsystems (education subsystem, community subsystem, resource subsystem, support service subsystem and policy subsystem). The coupling degree of education subsystem (Subsystem 1) shows a fluctuated rising trend between 2012 and 2022, the lowest point appears in 2016, then its curve rises steadily and the highest point appears in 2022, indicating that the degree of closeness between the education subsystem and college students' entrepreneurship was increasing during that period. The coupling degree of community subsystem (Subsystem 2) shows an upward trend since 2012, although it declines slightly during 2014 and 2015, overall speaking, it shows a steady growing trend over the years, and reaching the peak in 2022, this indicates that the importance of community environment in college students' entrepreneurship was increasing during the study period. As for the resource subsystem (Subsystem 3), between 2012 and 2016, the coupling degree increases first and decreases later, then between 2017 and 2022, it exhibits an upward trend, indicating that resource plays a more important role in college students' entrepreneurship. The overall trend of support service subsystem (Subsystem 4) doesn't fluctuate much, but after 2018, it shows a slight upward trend, suggesting that the role of support services in college students' entrepreneurship is becoming increasingly important. As for the policy subsystem (Subsystem 5), apart from a decline between 2014 and 2016, its overall trend is steady growth during the study period, especially after 2017, the influence of policies on college students' entrepreneurship enhances significantly. In summary, the coupling degree of the five subsystems rises in fluctuations over the past ten years, wherein the growth of the coupling degree of the community subsystem and the policy subsystem is more obvious, indicating that the influence of community environment and policy support on college students' entrepreneurship grows greater, and this reminds us to comprehensively consider the action of all subsystems when promoting the entrepreneurship of college students, and efforts should be made to improve and optimize educational environment, community atmosphere, resource provision, support services, and policy incentives.

Based on the data in Table 2, the coupling between O_1 (the mutual relationship between the support of educational environment and the transformation of student entrepreneurs' achievements), O_2 (the influence degree of the support of educational environment on the transformation of student entrepreneurs' achievements), and O_3 (the possible performance of the transformation of student entrepreneurs' achievements under the support of educational environment). The value of O_1 shows a growing trend from 2017 to 2022, indicating the relationship between the support of educational environment and the transformation of student entrepreneurs' achievements becomes tighter gradually. The value of O_2 shows a significant growth in 2022, indicating that the influence of the support of educational environment on the transformation of student entrepreneurs' achievements gets stronger over the time. The value of O_3 increases from 2017 to 2020, but shows a minor drop

in 2021 and 2022, suggesting that the transformation efficiency of student entrepreneurs' achievements under the support of educational environment is high but the growing speed slows down. It can be known from the table, the relationship intensity, influence degree, and performance between the support of educational environment and the transformation of student entrepreneurs' achievements had all improved, although the overall consistency (namely the coupling degree) declined in recent two years, the coordination (namely the coupling-coordinating degree) was on the rise, indicating that the support of educational environment is critical for increasing the transformation of student entrepreneurs' achievements, and the coordination of the two needs to be improved further.

Table 2. Model calculation results

Year	O_1	O_2	O_3	Coupling Degree	Coupling-Coordinating Degree
2017	0.103	0.031	0.164	0.244	0.264
2018	0.154	0.054	0.024	0.241	0.254
2019	0.112	0.094	0.194	0.341	0.334
2020	0.184	0.164	0.201	0.347	0.384
2021	0.211	0.234	0.211	0.332	0.404
2022	0.234	0.412	0.211	0.324	0.424

Table 3. Values of the coupling degree

Year	2017	2018	2019
Coupling degree	0.241 (Low-degree coupling)	0.211 (Low-degree coupling)	0.319 (Adjusting period)
Coupling-coordinating degree	0.264 (Low-degree coordination)	0.251 (Low-degree coordination)	0.338 (Moderate-degree coordination)
Year	**2020**	**2021**	**2022**
Coupling degree	0.312 (Adjusting period)	0.331 (Adjusting period)	0.321 (Adjusting period)
Coupling-coordinating degree	0.346 (Moderate-degree coordination)	0.241 (Moderate-degree coordination)	0.134 (Moderate-degree coordination)

Furthermore, Table 3 analyzes the coupling degree of the CSE network under different years' educational environment support, and draws the following conclusion: in 2017 and 2018, both the coupling degree and the coupling-coordinating degree were low, indicating in these two years, there wasn't a close connection formed between the support of educational environment and the transformation of student entrepreneurs' achievements, and there wasn't an effective coordination mechanism. Since 2019, the coupling degree entered an adjusting period, which means that the relationship between the support of educational environment and the transformation of student entrepreneurs' achievements became closer and tighter. In the meantime, the coupling-coordinating degree increased to a moderate level, indicating that the coordination between the support of educational environment and the transformation of student entrepreneurs' achievements had been improved to a certain extent. From 2020 to 2022, the coupling degree remained in the adjusting period, while the coupling-coordinating degree fluctuated, this implies that during

this period, although the relationship between the support of educational environment and the transformation of student entrepreneurs' achievements remained relatively tight, the coordination mechanism showed some changes and adjustments.

6 CONCLUSION

This study explored the coupling problem between the support of educational environment and the transformation of student entrepreneurs' achievements. At first, a CSE network under the support of educational environment was built, and the cooperation mode of student entrepreneurs was presented. Then, the transformation ability of student entrepreneurs' achievements was measured based on SBM, a model for measuring the coupling between the support of educational environment and the transformation of student entrepreneurs' achievements was constructed, and the modeling steps were introduced in detail. Based on above four modes, the relationship between the support of educational environment and the transformation of student entrepreneurs' achievements was reflected. After that, the coupling trend of five subsystems, including education subsystem, community subsystem, resource subsystem, support service subsystem and policy subsystem, was analyzed. At last, combining with an actual example, the trend of the coupling model was analyzed and the corresponding analysis results were given.

7 ACKNOWLEDGEMENTS

The research was founded within the project No. JRSHZ-2019-02101 entitled: "Research on training methods of innovative ability of logistics management professionals in Higher Vocational Colleges", being a part of Talent Training program "Cultivation of innovation ability" supported by Hebei provincial Department of Human Resources and Social Security.

8 REFERENCES

[1] Kusdiyanti, H., Karkono, Sopingi, Febrianto, I., Wijaya, R., Agustina, N.I. (2022). Development of Edu-Kit media for entrepreneurship learning based on gamification model toward disruptive education. International Journal of Interactive Mobile Technologies, 16(4): 17–29. https://doi.org/10.3991/ijim.v16i04.28985

[2] Pratikto, H., Hanafiya, R., Ashar, M., Akbar, M.I., Harsono, Y.T. (2021). Entrepreneurship game apps to enhancement student skill thinking analytic in class online. International Journal of Interactive Mobile Technologies, 15(8): 155–162. https://doi.org/10.3991/ijim.v15i08.21575

[3] Idris, M.O., Adeboye, B.S., Adeyemi, O.A., Abanikannda, M.O., Lawal, N.A., Lawal, M.O. (2022). Assessment of engineering entrepreneurship intentions among engineering students of Osun State University, Nigeria. International Journal of Engineering Pedagogy, 12(4): 85–97. https://doi.org/10.3991/ijep.v12i4.30111

[4] Li, P., Gong, L., Miao, Y., Zhao, Y., Li, A., Ren, H. (2023). Higher vocational students' innovation and entrepreneurship ability demand prediction. International Journal of Emerging Technologies in Learning, 18(8): 96–209. https://doi.org/10.3991/ijet.v18i08.39249

[5] Cui, L., Bai, S., Tang, Y. (2022). Interaction mechanism for the entrepreneurship of college students with diversified values. International Journal of Emerging Technologies in Learning, 17(13): 84–100. https://doi.org/10.3991/ijet.v17i13.32801
[6] Ruiz, P.A., Kayahan, C. (2021). Entrepreneurship among young people in Spain and Turkey: Incentives and challenges to overcome. Journal of Corporate Governance, Insurance, and Risk Management, 8(1): 201–215. https://doi.org/10.51410/jcgirm.8.1.13
[7] Jiang, Y., Pan, J., Liu, M., Gao, X. (2022). The relationship between college students' entrepreneurial intention and the teaching quality of innovation and entrepreneurship practice. International Journal of Emerging Technologies in Learning, 17(12): 61–76. https://doi.org/10.3991/ijet.v17i12.32081
[8] Zhao, D., Liang, H.W. (2022). Design of innovation and entrepreneurship effect evaluation system for college students based on MOA model. In IoT and Big Data Technologies for Health Care: Second EAI International Conference, IoTCare 2021, Virtual Event, pp. 183–198. https://doi.org/10.1007/978-3-030-94182-6_14
[9] Wang, C., Dong, Y., Xia, Y., Li, G., Martínez, O.S., Crespo, R.G. (2022). Management and entrepreneurship management mechanism of college students based on support vector machine algorithm. Computational Intelligence, 38(3): 842–854. https://doi.org/10.1111/coin.12430
[10] Liang, G., Alghazzawi, D.M., Joseph, N.R. (2022). The evaluation of college students' innovation and entrepreneurship ability based on nonlinear model. Applied Mathematics and Nonlinear Sciences, 7(1): 791–802. https://doi.org/10.2478/amns.2021.2.00101
[11] Miao, Y., Fan, H., Yuan, B. (2021). Optimization of supporting college students entrepreneurship environment. Computer Applications in Engineering Education, 29(2): 445–452. https://doi.org/10.1002/cae.22228
[12] Tian, X. (2013). Establishment of policy support system for college students' entrepreneurship in Suzhou. International Journal of Emerging Technologies in Learning, 8(5): 27–31. https://doi.org/10.3991/ijet.v8i5.2995
[13] Guan, X., Fan, Y., Qin, Q., Deng, K., Yang, G. (2020). Construction of science and technology achievement transfer and transformation platform based on deep learning and data mining technology. Journal of Intelligent & Fuzzy Systems, 39(2): 1843–1854. https://doi.org/10.3233/JIFS-179956
[14] Lin, S., Cai, S., Sun, J., Wang, S., Zhao, D. (2019). Influencing mechanism and achievement of manufacturing transformation and upgrading: Empirical analysis based on PLS-SEM model. Journal of Manufacturing Technology Management, 30(1): 213–232. https://doi.org/10.1108/JMTM-05-2018-0126
[15] Maree, Michiel David; Strydom, Ian; Matthee, Machdel. (September 29, 2014). Towards a framework for the achievement of mobile transformation in enterprises. ACM International Conference Proceeding Series, 28-September-2014: 343–351. https://doi.org/10.1108/JMTM-05-2018-0126
[16] Wang, Y., Wang, H., Chen, J., Zheng, Y., Li, C., Liu, T., Lu, H., Kejin, Z. (2023). Achieving polycrystalline transformation and microstructural segregation reduction of nickel-based single crystal super-alloys by ultrasonic pulse arc welding. Journal of Materials Research and Technology, 24: 2200–2212. https://doi.org/10.1016/j.jmrt.2023.03.114
[17] Suo, Q. (2013). Knowledge Structure Research on Achievement Transformation in Scientific and Technical Research Talented Person. In The 19th International Conference on Industrial Engineering and Engineering Management: Management System Innovation, pp. 507–514. https://doi.org/10.1007/978-3-642-38427-1_54
[18] Guo, S.D., Guo, X.S., Wang, G.Z., Cheng, K., Ang, Y.S. (2022). Electric-field induced magnetic-anisotropy transformation to achieve spontaneous valley polarization. Journal of Materials Chemistry C, 10(43): 16363–16369. https://doi.org/10.1039/D2TC03293G

[19] Liu, Y., Zhu, Q., Chen, D. (2021). Implement innovation-driven strategy to build a system for the transformation of scientific and technological achievements-An example of Yunnan power grid corporation. E3S Web of Conferences, 235: 01008. https://doi.org/10.1051/e3sconf/202123501008

[20] Cheng, H., Zhang, Z., Huang, Q., Liao, Z. (2020). The effect of university–industry collaboration policy on universities' knowledge innovation and achievements transformation: Based on innovation chain. The Journal of Technology Transfer, 45: 522–543. https://doi.org/10.1007/s10961-018-9653-9

[21] Song, R. (2022). Design of innovation and entrepreneurship achievement transformation platform based on PHP and data center model. In 2022 International Conference on Sustainable Computing and Data Communication Systems (ICSCDS), Erode, India, pp. 1338–1342. https://doi.org/10.1109/ICSCDS53736.2022.9760745

9 AUTHORS

Lijun Wang, graduated from Lanzhou University and obtained a degree in Management. Currently, she works at Shijiazhuang University of Applied Technology, and focuses on marketing and vocational education. Email: 2002010249@sjzpt.edu.cn

Liping Qu, graduated from Shijiazhuang Tiedao University and obtained a degree in Transportation Engineering. Currently, she works at Shijiazhuang University of Applied Technology, and focuses on business administration and vocational education. Email: 2013010660@sjzpt.edu.cn

Shanshan Wang, graduated from Hebei University of Technology with a master's degree, she is currently working at Shijiazhuang University of Applied Technology, and focuses on business administration. Email: 2017010823@sjzpt.edu.cn