Relationship between Knowledge Flow of Scientific and Technological Innovation and the Collaborative Innovation Ability of Students

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Abstract—Scientific and technological innovation ability of students is an important part of scientific and technological innovation in higher vocational colleges. There are few scientific and technological innovation achievements and low scientific and technological content of technical application achievements in higher vocational colleges at present, which are mainly caused by the single innovation organization form and weak innovation knowledge sharing ability. It is of great significance and value to explore the knowledge flow of scientific and technological innovation in colleges and universities and the collaborative innovation of college students. There is little research on the relationship between knowledge flow of scientific and technological innovation and collaborative innovation of college students in the existing literature, so this article has carried out relevant research. This article constructs the mathematical model of knowledge flow of scientific and technological innovation in colleges and universities, analyzes the stability of the mathematical model of knowledge flow of scientific and technological innovation in colleges and universities, and gives the framework of collaborative innovation ecosystem for college students. This article accurately measures the embedding of scientific and technological innovation resources in colleges and universities, the knowledge flow of scientific and technological innovation and the collaborative innovation performance of college students, and empirically tests the direct influence effect of embedding scientific and technological innovation resource network in colleges and universities on the collaborative innovation performance of college students and the moderating effect of the knowledge flow of scientific and technological innovation in colleges and universities. Finally, the corresponding experimental analysis results are given.

Keywords—scientific and technological innovation in colleges and universities, knowledge flow, collaborative innovation of college students

1 Introduction

Scientific and technological innovation of college students in higher vocational colleges mainly includes scientific research and technological innovation facing production technology problems, which is an important part of scientific and technological innovation in higher vocational colleges [1–5]. At present, although the scientific and technological innovation activities of students from higher vocational colleges have made certain achievements [6–9], there are few innovative achievements that can be applied to actual production, and the scientific and technological content of technical application achievements is low, which is caused by many factors such as single innovation organization form [10, 11] and weak innovation knowledge sharing ability [12–17], which directly or indirectly reflect the innovation enthusiasm and innovation performance of scientific research teams and individual college students. Therefore, it is of great significance and value to explore the knowledge flow of scientific and technological innovation in colleges and universities and the collaborative innovation of college students.

One of the most difficult tasks for higher vocational colleges is to implement effective and constructive changes in the already running system. Muftahu and Jamil [18] aims to describe how to promote knowledge flow and adopt innovative thinking in the context of higher vocational colleges. In addition, three areas of fully implementing or changing management plan are discussed: structure, culture and strategy. The proposed change management plan shows how to implement change initiatives in higher education institutions in the context of knowledge flow and innovative thinking. In order to better understand and apply knowledge reuse in knowledge flow, when fundamental innovation is expected, Zhao et al. [19] chooses academic research field, and dynamically analyzes the principle and process of knowledge reuse from the perspective of “time and space” under the background of knowledge flow. Knowledge reuse is divided into four stages, namely, knowledge search, knowledge evaluation, knowledge reorganization and knowledge creation, and a knowledge reuse mechanism model centered on these stages is developed. Caloghirou et al. [20] discusses the relationship between R&D cooperation and product innovation in industrial universities (I-U), and how this relationship is influenced by the knowledge stock of different types of scientific research and innovation teams in colleges and universities represented by the age of scientific research and innovation teams, the education level of employees and export activities in colleges and universities. The results show that the innovation teams with low knowledge stock benefit more from the development of knowledge flow with universities. Knowledge flow is a dominant behavior of college students in the process of cooperative and innovative learning. The existing research on knowledge flow management mechanism of CIL platform generally lacks systematic theoretical analysis on the mechanism of influencing factors, and few studies discuss the influence of CIL platform management mechanism on knowledge flow from a dynamic perspective. Wang [21] explains the formation mechanism of CIL network, and measures the model variables of the proposed network. Then, the robustness of network function based on knowledge flow is analyzed, and the results of multi-factor variable analysis of the model are given. Shi [22] analyzes the current situation of college students’ innovation and entrepreneurship resources recommendation. Then, this article proposes an algorithm of collaborative filtering recommendation technology.

By combing existing literatures, it's possible to see that scholars at home and abroad have made some achievements in the research of knowledge flow of scientific and technological innovation in colleges and universities and collaborative innovation of college students, but few literatures dig deep into the relationship between them. Therefore, this article has carried out related research.

2 Construction and stability analysis of knowledge flow model of scientific and technological innovation in colleges and universities

Knowledge is an important part of organizational resources, and knowledge flow of scientific and technological innovation in colleges and universities is also an important behavior in the process of collaborative innovation of college students. The new technology of actual production application scenarios has high complexity, which cannot be controlled by individual college students. In the process of college students' collaborative innovation, it's possible to realize the exchange, exploration and integration of scientific and technological innovation knowledge with the help of scientific and technological innovation platforms in colleges and universities, which can effectively improve the innovation performance, and then achieve the purpose of technology popularization, application and industrialization.

Knowledge flow of scientific and technological innovation in colleges and universities is an interactive exchange among scientific and technological innovation teams in colleges and universities. In order to obtain the expected psychological benefits, the subject of college students' collaborative innovation decides to share knowledge and pay the cost of the corresponding collaborative innovation. If the subject of collaborative innovation of college students is afraid of paying the cost of collaborative innovation or feels that even if they pay, they will not get the corresponding return, the subject will choose to avoid participating in the knowledge flow of scientific and technological innovation. The cost of collaborative innovation here can be support of a special professional ability or innovative resources with unique advantages. Therefore, this article will study the formation mechanism of knowledge flow of scientific and technological innovation in colleges and universities from the perspective of mutually beneficial relationship among subjects of college students' collaborative innovation.

Firstly, this article constructs the mathematical model of knowledge flow of scientific and technological innovation in colleges and universities. Considering that reciprocity and mutual benefit are the key indicators of knowledge flow in scientific and technological innovation, it can be characterized by the knowledge stock of collaborative innovation subjects. If the knowledge stock of collaborative innovation subjects is increasing, it shows that the reciprocity and mutual benefit of collaborative innovation subjects is good, and the knowledge flow within the team is in good condition. If the knowledge stock of collaborative innovation subjects remains unchanged or has negative growth, it shows that the reciprocity and mutual benefit of collaborative innovation subjects are poor, and the knowledge flow within the team is stagnant. In addition, this article chooses the contract spirit and shared trust of knowledge sharing of scientific and technological innovation in colleges and universities as the decision variables of the model, which are measured by the satisfaction degree of contract spirit and the level of shared trust respectively.

It is assumed that the knowledge stock of collaborative innovation subjects O_1 and O_2 at time o is represented by $L_1(o)$ and $L_2(o)$ respectively, satisfying $L_1(o) > 0$ and $L_2(o) > 0$. The natural growth rate of knowledge of collaborative innovation subjects O_1 and O_2 when the knowledge flow within the team is stagnant is represented by s_1 and s_2 respectively, satisfying $s_1 > 0$ and $s_2 > 0$. The knowledge saturation values of collaborative innovation subjects O_1 and O_2 are represented by M_1 and M_2 respectively, satisfying $M_1 > 0$ and $M_2 > 0$. When the knowledge flow within the team is stagnant, the change law of knowledge stock of collaborative innovation subjects O_1 and O_2 conforms to the growth law of Logistic model. The following formula gives a specific expression to characterize the process that collaborative innovation subjects O_1 and O_2 share innovative knowledge and lead to the stagnation of their own knowledge growth:

$$\frac{dL_1(o)}{do} = s_1 L_1\left(1 - \frac{L_1}{M_1}\right) \tag{1}$$

$$\frac{dL_2(o)}{do} = s_2 L_2\left(1 - \frac{L_2}{M_2}\right) \tag{2}$$

The satisfaction degree of contract spirit has a positive impact on the willingness of collaborative innovation subjects to share knowledge of scientific and technological innovation. When the satisfaction degree of contract spirit is high, collaborative innovation subjects will share and contribute innovative knowledge to other subjects. It is assumed that the psychological satisfaction of collaborative innovation subjects O_1 and O_2 in the active knowledge flow within the team is expressed by β_1 and β_2, respectively, satisfying $\beta_1 > 0$ and $\beta_2 > 0$. The above formula can be amended to read:

$$\frac{dL_1(o)}{do} = s_1 L_1\left(1 - \frac{L_1}{M_1} + \beta_2 \frac{L_2}{M_2}\right) \tag{3}$$

$$\frac{dL_2(o)}{do} = s_2 L_2\left(1 - \frac{L_2}{M_2} + \beta_1 \frac{L_1}{M_1}\right) \tag{4}$$

There are both cooperative and competitive relationships among the collaborative innovation subjects in the scientific and technological innovation teams of colleges and universities. When the level of shared trust among collaborative innovation subjects is low, they will refuse to share and contribute innovative knowledge to other subjects. This behavior will inhibit the innovation knowledge growth of all collaborative innovation subjects, which is not conducive to the knowledge flow within the team. Furthermore, it is assumed that the shared trust levels of collaborative innovation subjects

O_1 and O_2 in the active knowledge flow within the team are expressed by γ_1 and γ_2, respectively, satisfying $\gamma_1 > 0$ and $\gamma_2 > 0$. To continue to revise the above formula, then:

$$\frac{dL_1(o)}{do} = s_1 L_1 \left(1 - \frac{L_1}{M_1} + \beta_2 \frac{L_2}{M_2} - \gamma_2 \frac{L_2}{M_2}\right) \tag{5}$$

$$\frac{dL_2(o)}{do} = s_2 L_2 \left(1 - \frac{L_2}{M_2} + \beta_1 \frac{L_1}{M_1} - \gamma_1 \frac{L_1}{M_1}\right) \tag{6}$$

Combining the above two formulas, a Logistic model of knowledge flow of scientific and technological innovation in colleges and universities can be constructed, which can reflect the influence of contract spirit and shared trust on collaborative innovation subjects:

$$\begin{cases} \dfrac{dL_1(o)}{do} = s_1 L_1 \left(1 - \dfrac{L_1}{M_1} + \beta_2 \dfrac{L_2}{M_2} - \gamma_2 \dfrac{L_2}{M_2}\right) \\ \dfrac{dL_2(o)}{do} = s_2 L_2 \left(1 - \dfrac{L_2}{M_2} + \beta_1 \dfrac{L_1}{M_1} - \gamma_1 \dfrac{L_1}{M_1}\right) \end{cases} \tag{7}$$

Then, according to the model, this article chooses differential equation stability analysis method to discuss the equilibrium state of knowledge flow of scientific and technological innovation in colleges and universities, that's, to analyze the development law and development trend of knowledge flow within scientific and technological innovation teams in colleges and universities when the time o tends to infinity. To solve the above formula, then:

$$\begin{cases} \dfrac{dL_1(o)}{do} = s_1 L_1 \left(1 - \dfrac{L_1}{M_1} + \beta_2 \dfrac{L_2}{M_2} - \gamma_2 \dfrac{L_2}{M_2}\right) = 0 \\ \dfrac{dL_2(o)}{do} = s_2 L_2 \left(1 - \dfrac{L_2}{M_2} + \beta_1 \dfrac{L_1}{M_1} - \gamma_1 \dfrac{L_1}{M_1}\right) = 0 \end{cases} \tag{8}$$

$Z_1(0,0)$, $Z_2(N_1,0)$, $Z_3(0,M_2)$, $Z_4[M_1(1+\beta_1-\gamma_1)/1-(\beta_1-\gamma_1)(\beta_2-\gamma_2)$ and $M_2(1+\beta_2-\gamma_2)/1-(\beta_1-\gamma_1)(\beta_2-\gamma_2)]$ are obtained by solving the solution. The constructed Jacobian matrix is given by the following formula:

$$Jacobian = \begin{bmatrix} s_1\left[1+(\beta_1-\gamma_1)\dfrac{L_2}{M_2}-2\dfrac{L_1}{M_1}\right] & s_1(\beta_1-\gamma_1)\dfrac{L_1}{M_1} \\ s_2(\beta_2-\gamma_2)\dfrac{L_2}{M_2} & s_2\left[1+(\beta_2-\gamma_2)\dfrac{L_1}{M_1}-2\dfrac{L_2}{M_2}\right] \end{bmatrix} \tag{9}$$

When $detJacobian = |Jacobian| > 0$ and $tr\ Jacobian < 0$, it can be judged that the equilibrium point obtained by solving the solution reaches the local steady state of knowledge flow. Especially, when $\beta_1 + \gamma_1 < -1$ or $\beta_2 + \gamma_2 < -1$, the value of equilibrium point Z_2 or Z_3 does not conform to the actual situation, but it is judged as the local stable equilibrium point of knowledge flow, that's, the initial value of knowledge stock level of collaborative innovation subjects in teams is usually greater than 0. Similarly, in the process of collaborative scientific and technological innovation, the knowledge reserve of collaborative innovation subjects will increase, and their initial knowledge stock level will not reach saturation.

Now, the stability analysis of equilibrium point Z_4 is carried out. When $\beta_1 - \gamma_1 < 1$ and $\beta_2 - \gamma_2 < 1$, Z_4 can be judged as the local stable equilibrium point of knowledge flow. The phase trajectory diagram of equilibrium point stability analysis in the Logistic model of knowledge flow of scientific and technological innovation in colleges and universities is given in Figure 1.

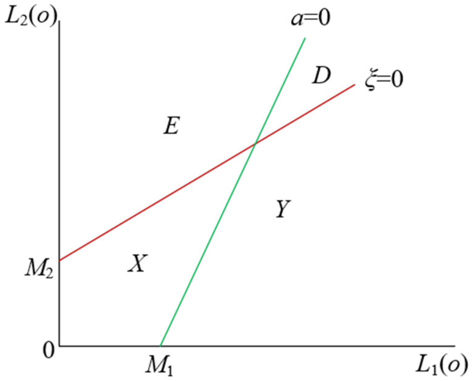


Fig. 1. Phase trajectory diagram

In this figure, $\Phi = 1 - L_1/M_1 + \beta_1 L_2/M_2 - \gamma_1 L_2/M_2$ and $\xi = 1 - L_2/M_2 + \beta_1 L_2/M_2 - \gamma_1 L_2/M_2$. The phase plane formed by $L_1(o)L_2(o)$ is divided into four regions: X, Y, D and E by two straight lines $a = 0$ and $\xi = 0$. It can be seen from the figure that when o tends to infinity, the trajectory will tend to Z_4 no matter which region X, Y, D and E start from.

According to the above analysis, when $0 < \beta_1 + \gamma_1 < 1$ and $0 < \beta_2 + \gamma_2 < 1$ and the contract spirit and shared trust have little influence on collaborative innovation subjects, a stable collaborative innovation relationship is constructed among collaborative innovation subjects, and the knowledge flow of scientific and technological innovation is formed. At this time, as $M_1(1 + \beta_1 - \gamma_1)/1 - (\beta_1 - \gamma_1)(\beta_2 - \gamma_2) > M_1$ and $M_2(1 + \beta_2 - \gamma_2)/1 - (\beta_1 - \gamma_1)(\beta_2 - \gamma_2) > M_1$, the knowledge stock level of collaborative innovation subjects is greater than that before collaborative innovation. It can be seen that when the satisfaction degree of contract spirit and the level of shared trust of collaborative innovation subjects are maintained in an ideal state, that's, when $\beta_1 - \gamma_1 < 1$ and $\beta_2 - \gamma_2 < 1$, the collaborative innovation relationship among collaborative innovation subjects is relatively stable, and the active knowledge flow of scientific and technological innovation appears in the team, which promotes the improvement of knowledge stock level of collaborative innovation subjects to varying degrees.

3 Correlation analysis of resource network embedding, knowledge flow and collaborative innovation performance

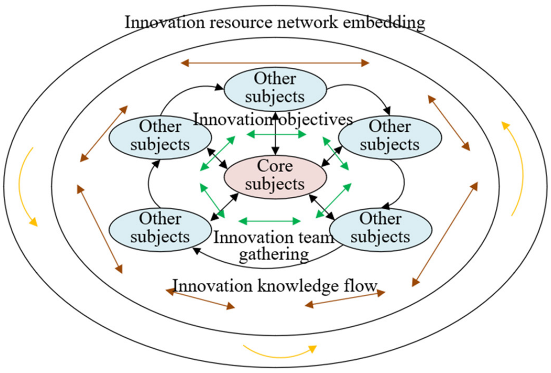


Fig. 2. Schematic diagram of collaborative innovation ecosystem model for college students

Collaborative innovation is a network innovation mode with college students as the core element and multiple subjects interacting with each other. Through the in-depth cooperation among the subjects and the integration of scientific and technological innovation resources in colleges and universities, it can accelerate the production of multiple innovation effects.

The increase of sustainable innovation knowledge stock is not only the ultimate goal of collaborative innovation ecology of college students, but also the inherent requirement of scientific and technological innovation team. Therefore, the increase of innovation knowledge stock requires not only the interaction and reciprocity among collaborative innovation subjects, but also the integration of innovation resources within the team and resources from the scientific and technological innovation resource network in colleges and universities (Figure 2).

Based on the research results of the previous section, this article selects scientific indicators and measurement methods to accurately measure the network embedding of scientific and technological innovation resources in colleges and universities, the knowledge flow of scientific and technological innovation in colleges and universities and the collaborative innovation performance of college students. This article constructs a mathematical model to empirically test the direct effect of the embedding of scientific and technological innovation resource network on the collaborative innovation performance of college students and the moderating effect of the knowledge flow of scientific and technological innovation in colleges and universities. The model selects appropriate adjustment variables and control variables, and takes the network structure embedding and relationship embedding of scientific and technological innovation resources in colleges and universities as explanatory variables, and the collaborative innovation performance of college students as explanatory variables. Accurate measurement of all variables can be realized through scientific measurement methods. Figure 3 shows the correlation analysis process of embedding scientific and technological innovation resource network in colleges and universities, the knowledge flow of scientific and technological innovation in colleges and universities and college students' collaborative innovation performance.

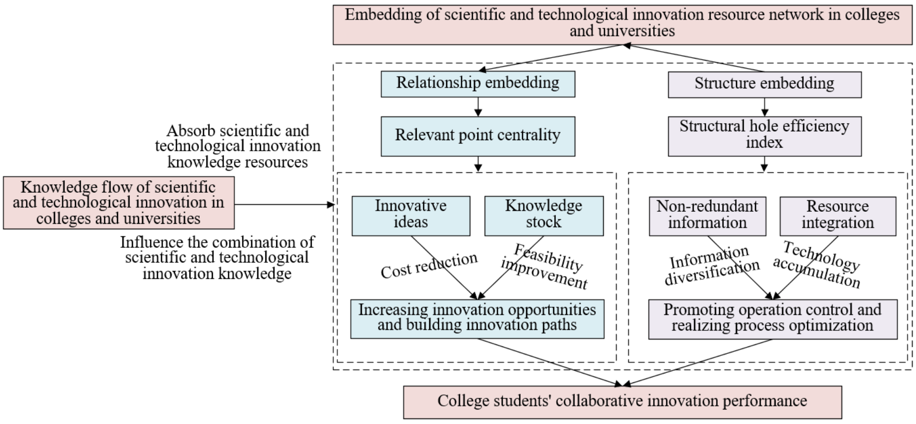


Fig. 3. Correlation analysis process

Collaborative innovation performance of college students can be measured by the number of invention patents granted, and knowledge flow measurement can be obtained through the analysis in the previous section. Adjustment variables and control variables are the innovation goals and basic attributes of collaborative innovation teams, with a relatively simple quantification process. The following is a detailed introduction to the measurement and analysis of network structure embedding and relationship embedding of scientific and technological innovation resources in colleges and universities.

Traditional embedding measurement of scientific research and innovation resource network in colleges and universities is generally realized by structural hole analysis. Therefore, this article selects two structural hole network indicators, i.e., efficiency index and limitation index, to measure the embedding of scientific and technological innovation resource network in colleges and universities, which can be calculated by the ratio of non-redundant connection to total connection of target innovation knowledge. It's assumed that the target innovation knowledge in each time window is represented by i, other innovation knowledge related to i is represented by j, and the third innovation knowledge besides i and j in the scientific and technological innovation resource network in colleges and universities is represented by w. The proportional strength of the connection between innovative knowledge i and w is represented by Z_{iw}, and the marginal strength of the relationship between innovative knowledge j and w is represented by n_{jw}. The actual network size of innovative knowledge i is represented by E_i, then:

$$PGG_i = \left[\sum_j \left(1 - \sum_w z_{iw} n_{jw} \right) \right] / E_i \tag{10}$$

Based on the specific research objectives and research situation of this article, the average value of structural holes occupied by innovation knowledge owned by scientific research and innovation teams in colleges and universities is used to measure the embedding level of scientific and technological innovation resources network structure in colleges and universities. After generating the adjacency matrix of scientific and technological innovation resources relationship in colleges and universities in each time window, the structural hole efficiency index of each innovation knowledge category can be obtained by calculating each window based on the above formula. Finally, the structure embedding level of scientific and technological innovation resource network in colleges and universities is quantified by using the average value of structure holes of innovation knowledge categories owned by scientific and technological innovation resource network in colleges and universities. Assuming that the number of innovative knowledge owned by collaborative innovation subjects in each time window is represented by *M* and the innovative knowledge owned by collaborative innovation subjects in the corresponding time window is represented by *i*, then:

$$X\_PGG_i = \frac{1}{M}\sum_{i=1}^{M}\left\{\left[\sum_j \left(1-\sum_w z_{iw}n_{jw}\right)\right]/E_i\right\} \tag{11}$$

The embedding level of resource network relationship can be measured by calculating absolute point centrality and relative point centrality. Because the point centrality is comparable under the premise of considering the scale of scientific and technological innovation resources network in colleges and universities, this article selects the relative point centrality index for relevant measurement and analysis. The relative point centrality value can be obtained by comparing the absolute number of connections between target innovation knowledge and other innovation knowledge to the number of connections between target innovation knowledge and other innovation knowledge that are most likely related to target innovation knowledge. The larger the value is, the more other innovative knowledge related to the target innovative knowledge is, and the higher the relationship embedding level of the target innovative knowledge is. Assuming that the target innovation knowledge in each time window is represented by *i*, if there is a connection between *i* and *j* in the innovation knowledge in the scientific and technological innovation resource network, $A_{ij}=1$; otherwise $A_{ij}=0$. If the total number of innovative knowledge in the scientific and technological innovation resource network is expressed by *h*, the possible maximum connections of innovative knowledge *i* in the resource network is expressed by $(h-1)$. The following formula gives the calculation method of relative point centrality:

$$MSN(m_i) = \sum_j A_{ij}/(h-1) \tag{12}$$

Based on the specific research objectives and research context of this article, this article also selects the innovation knowledge relationship embedding level of scientific research and innovation teams in colleges and universities to measure the relationship embedding level of scientific and technological innovation resource network of the team. After generating the adjacency matrix of the relationship between scientific and technological innovation resources in colleges and universities in each time window, the relative point centrality of each innovation knowledge category can be obtained by calculating each window based on the above formula. Finally, the average value of the relationship embedding level of innovation knowledge categories owned by the scientific research and innovation team in colleges and universities is used to calculate the relationship embedding level of the team's resource network. The following gives the specific calculation formula:

$$X\_MSN(m_i) = \frac{1}{M}\sum_{i=1}^{M}\left[\sum\nolimits_j A_{ij}/(h-1)\right] \tag{13}$$

4 Experimental results and analysis

Table 1 gives descriptive statistical results of observed variables involved in the model constructed in this article, including mean, standard deviation, minimum, median and maximum of regulatory variables, control variables, explanatory variables and explained variables. It can be seen from Table 1 that there are great differences in collaborative innovation performance of college students, with a certain room for improvement. The average value of embedded variables in the network structure of scientific and technological innovation resources in colleges and universities is 0.615, which shows that scientific research and innovation teams in colleges and universities with high structural hole efficiency index can obtain more innovation performance by means of resource integration in the collaborative innovation process. The distribution characteristics of observed values embedded in the network of scientific and technological innovation resources in colleges and universities are similar to those embedded in the structure, which shows that there is a connection between the existing knowledge stock of scientific research and innovation teams in colleges and universities and the innovative knowledge resources in the network of scientific and technological innovation resources in colleges and universities.

Table 1. Descriptive statistics of observed variables

	Mean Value	**SD**	**Minimum**	**Median**	**Maximum**
Innovation performance	12.305	35.629	0.102	3.201	815
Structure embedding	0.615	0.026	0.362	0.629	0.837
Relationship embedding	0.462	0.174	0.025	0.415	1.205
Team creation duration	12.625	5.362	0.001	13	46
Knowledge type	11.302	19.251	2	11	115
Knowledge stock	85.324	162.385	3	36	2618
Transformation of innovation achievements	0.036	0.162	–0.519	0.025	1.602
Number of team members	23.528	1.859	16.325	22.417	29.362

In terms of control variables, the average creation time of scientific research and innovation teams in colleges and universities is 12.625, which shows that the samples include scientific research and innovation teams in different stages such as initial stage, growth stage and mature stage. The average value of knowledge types is 11.302, which shows that there are great differences in the knowledge stock of scientific research and innovation teams in different colleges and universities, and the knowledge categories mastered by scientific research and innovation teams in different colleges and universities are unevenly distributed. The median of knowledge stock is 85.324, which shows that the knowledge accumulation and distribution of scientific research and innovation teams in colleges and universities are uneven. The minimum value of innovation achievement transformation is –0.519, which shows that there are great differences in innovation achievement transformation ability among scientific research and innovation teams in different colleges and universities. The average number of scientific research and innovation team members in colleges and universities is 23.528, which shows that there are differences in the size of scientific research and innovation teams in different colleges and universities.

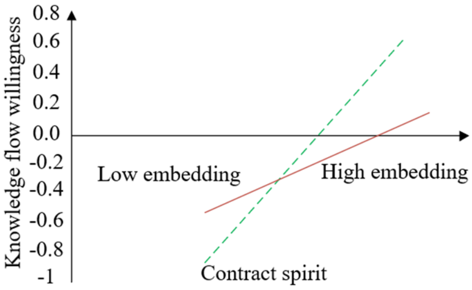


Fig. 4. The moderating effect of resource network embedding between contract spirit and knowledge flow willingness

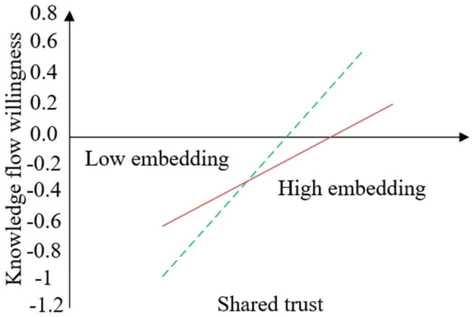


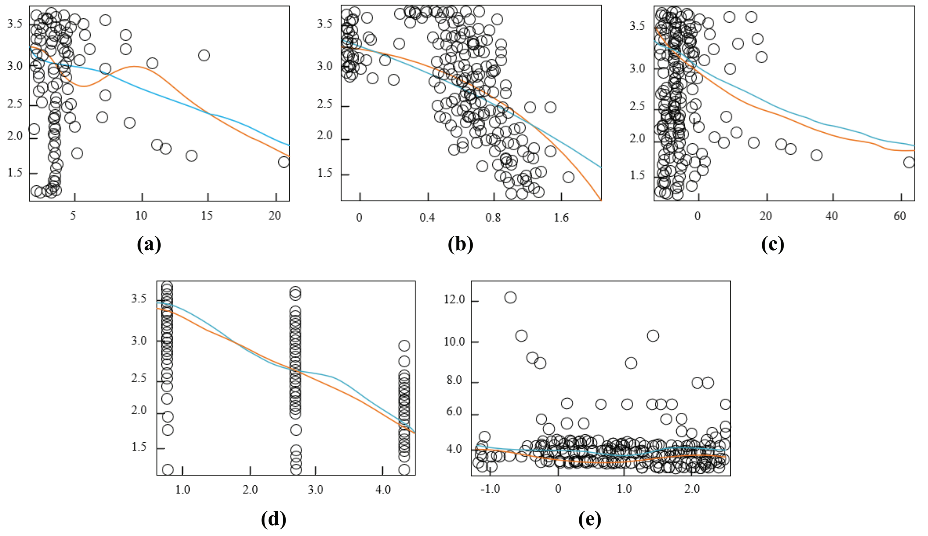
Fig. 5. The moderating effect of resource network embedding between shared trust and knowledge flow willingness

Based on the conditional process model, this article tests the moderating effect of resource network embedding among contract spirit, shared trust and knowledge flow willingness, and sets Bootstrap extraction for 10000 times. In order to explain the essence of the interaction effect of contract spirit, shared trust and resource network embedding more clearly, Figures 4 and 5 show the simple moderating effect diagrams of contract spirit and shared trust at different values such as high (M + l SD) and low (M-1SD). The indirect influence of contract spirit and shared trust on knowledge flow willingness of scientific and technological innovation team changes with the change of resource network embedding degree. When the embedding degree of resource network is high, the mediating effect is strong and significant. When the embedding degree of resource network is weak, the mediating effect is weak and insignificant.

Table 2. Regression results of embedding of scientific research and innovation resource network in colleges and universities and innovation performance of scientific research and innovation teams in colleges and universities

	Model 1	**Model 2**	**Model 3**
Resource network embedding	6.528**	1.262*	1.629
	(3.14)	(2.16)	(1.35)
Team creation duration		−0.062	−0.041
		(−1.25)	(−1.69)
Knowledge type		0.036**	0.038*
		(3.52)	(3.95)
Knowledge stock		0.014*	0.028*
		(2.74)	(2.61)
Transformation of innovation achievements		0.063	0.017
		(0.11)	(0.23)
Number of team members		0.285**	0.295***
		(3.62)	(3.47)
year			Control
_cons	−1.258	−4.392***	−4.638*
	(−1.62)	(−3.67)	(−3.27)
Inalpha	1.306**	0.039*	0.314**
	(11.62)	(4.18)	(4.23)
N	2417	2241	2157
Psend R^2	0.026	0.162	0.196

This article further examines the influence of embedding of scientific research and innovation resource network in colleges and universities on innovation performance of scientific research and innovation teams in colleges and universities. The regression analysis results are given in Table 2. In this article, Models 1, 2 and 3 are constructed based on the number of control variables. Model 1 does not control any factors, while Model 2 controls the factors such as team creation duration and team size that may affect the innovation performance of scientific research and innovation teams in colleges and universities. Model 3 controls more factors such as structure embedding and innovation achievement transformation than Model 2. From the regression results of Model 1, it's possible to see that the regression of resource network embedding is significant at the level of 1%, which shows that resource network embedding has a significant positive effect on the innovation performance of scientific research and innovation teams in colleges and universities. In Models 2 and 3, the regression of resource network embedding is still significantly positive.



(a) **(b)** **(c)**

(d) **(e)**

Fig. 6. Index scatter matrix diagram of scientific research and innovation teams in colleges and universities

In order to comprehensively show the internal knowledge flow and innovation performance of scientific research and innovation teams embedded in the network of scientific research and innovation resources teams in colleges and universities, 108 scientific research and innovation teams from 10 colleges and universities are selected as examples to measure and analyze with UCINET6.214 software. The distribution of index values of scientific research and innovation teams in colleges and universities is shown in Figure 6, where on the main diagonal of each core density graph is the relative point centrality, structural hole efficiency index, knowledge type, knowledge stock and innovation achievement transformation ability. Combined with the existing analysis results, univariate has significant differences in innovation performance of scientific research and innovation teams in colleges and universities, internal knowledge flow and innovation performance of scientific research and innovation teams in colleges and universities under the embedding of scientific research and innovation resource network in colleges and universities, teams with advantages in relative point centrality, structural hole efficiency index, knowledge type and knowledge stock will produce more scientific research performance.

5 Conclusion

This article studies the relationship between knowledge flow of scientific and technological innovation in colleges and universities and collaborative innovation of college students. This article constructs the mathematical model of knowledge flow of scientific and technological innovation in colleges and universities, analyzes the stability of the mathematical model of knowledge flow of scientific and technological innovation in colleges and universities, and gives the framework of collaborative innovation ecosystem for college students. This article accurately measures the embedding of scientific and technological innovation resources in colleges and universities, the knowledge flow of scientific and technological innovation and the collaborative innovation performance of college students, and empirically tests the direct influence effect of embedding scientific and technological innovation resources in colleges and universities on the collaborative innovation performance of college students and the moderating effect of the knowledge flow of scientific and technological innovation in colleges and universities. The moderating effect of resource network embedding among contract spirit, shared trust and knowledge flow willingness is tested. The results show that the mediating effect is strong and significant when the degree of resource network embedding is high. The regression analysis between the network embedding of scientific research and innovation resources in colleges and universities and the innovation performance of scientific research and innovation teams in colleges and universities is carried out, and the corresponding regression analysis results are given. The index scatter matrix diagram of scientific research and innovation teams in colleges and universities is drawn, intuitively seeing that the internal knowledge flow and innovation performance of scientific research and innovation teams in colleges and universities. Under the embedding of scientific research and innovation resource network in colleges and universities, teams with advantages in relative point centrality, structural hole efficiency index, knowledge type and knowledge stock will produce more scientific research performance.

6 Acknowledgement

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