Influence Mechanism of Structural Characteristics of Interdisciplinary Knowledge Network on College Students' Innovation Ability

https://doi.org/10.3991/ijet.v18i03.38053

Tiejian Zhang, Lan Ma(✉), Junliang Liu
College of Urban and Rural Construction, Hebei Agricultural University, Baoding, China
malan@hebau.edu.cn

Abstract—Interdisciplinary scientific research method plays a significant role in promoting technological innovation. As the principal subject in scientific research activities, college students need to improve their innovation ability using interdisciplinary knowledge resources and knowledge network. Existing researches are mostly carried out from a single perspective of knowledge network, and ignore systematical analysis for interdisciplinary multilayer network. For that reason, the influence mechanism of structural characteristics of interdisciplinary knowledge network on college students' innovation ability is established in this article. An interdisciplinary-dependent multilayer network is built and network nodes are divided into interdisciplinary knowledge elements, scientific research theme, and discipline and specialty. Structure attribute of interdisciplinary knowledge network and relationship attribute of interdisciplinary knowledge elements are also used to calculate indicators at different knowledge dimensions, and specific indicator measurement modes are proposed. The regression model is built to explore direct influence mechanism of dynamic and static characteristics of interdisciplinary knowledge network on college students' innovation ability. A regression model is also built to further verify the regulating effect of disciplinary knowledge's network location attribute of college students' specialty in influence relationship between interdisciplinary knowledge network and college students' innovation ability. Last, corresponding analysis result is given based on experiment result.

Keywords—interdisciplinary, knowledge network structure, college students' innovation ability

1 Introduction

One significant development trend of science since the 20th century is its integration with technology and mutual penetration of science, technology, and society, i.e., the transformation from single disciplinary knowledge production mode into interdisciplinary interactive mode [1–5]. Interdisciplinary research has been advanced rapidly and its prosperity also reflects the basic situation for the development of science and technology in modern times, such as complicated scientific structure, organic scientific activity

and softened ideal objectives [6–13]. As the optimal mode oriented to practical research topic, interdisciplinary scientific research method has become an important impetus of promoting technological innovation [14–17]. As the important subject implementing scientific research activity, college students need to improve their innovation ability with interdisciplinary knowledge resources and knowledge network.

Research shows the sequence of learning activity at different social levels affects learning effect. In reference [18], quasi-experimental design was used: An interdisciplinary team composed of 24 junior college students is exposed under two different conditions: One is designed with Working in Progress (WIP) and the other isn't designed with Working in Progress (WOIP). In social mode of knowledge building, students under WIP condition have more conflict orientations and comprehensive consensus building statements, to consult and share knowledge. Interdisciplinary knowledge sharing means exchange, transmission and transfer among different disciplines. Different disciplines are diversified in terms of thought and method; for different disciplines, other analysis methods and measures can be used to solve disciplinary problems and jointly finish comprehensive research, so as to break disciplinary boundary and promote knowledge integration and innovation. In reference [19], the desire and demand characteristics of user's interdisciplinary knowledge sharing were investigated and analyzed. A library interdisciplinary knowledge sharing service system was built, which is focused on organic combination of sharing place and management mechanism of user, knowledge resources and interdisciplinary knowledge. In reference [20], users were attracted through user-focused design or combined design, which helps ensure technology meets user's needs actually. It provides more perspectives for an interdisciplinary team's cooperation, so that technology could meet needs of more extensive potential users better and avoid trap frequently. Interdisciplinary research promotes emergence of scientific innovation. A kind of method automatically discovering interdisciplinary research was proposed by He et al. [21]. Based on pre-trained model, BERT method generates IRD-BERT neural network model and is used to discover interdisciplinary research. IRD-BERT is used to simulate expert's domain knowledge and author keywords can be projected into vector space through this model. Keywords with semantic exception can be recognized according to keyword distribution of vector space. Article using author keywords may be interdisciplinary research. The method is applied to discover interdisciplinary research of deep learning research field with its performance superior to a similar method.

2 Building and variable measurement of interdisciplinary knowledge network

Choosing the optimal research representation and topic extraction method oriented to characteristics of college students' research topic plays a basic role in building interdisciplinary knowledge network. Figure 1 shows the building process of interdisciplinary knowledge network. As known from the figure, the optimal representation of research master map entails complete and accurate semantic expression of research topic and facilitates the calculation of association strength of research topic and knowledge unit of college students' specialty field.

An interdisciplinary-dependent multilayer network will be built in this article, where network nodes are divided into interdisciplinary knowledge elements, research topic and discipline and specialty. Figure 2 shows how interdisciplinary-dependent multilayer network is built. As shown by the figure, link network nodes based on syntagmatic relationship of interdisciplinary knowledge elements, affiliation of interdisciplinary knowledge elements with research topic and association relationship of discipline and specialty with research topic and build an interdisciplinary knowledge network, which is in favor of improving college students' technological innovation ability. Figure 3 shows architecture of interdisciplinary-dependent multilayer network.

In this article, indicators at different knowledge dimensions were calculated through structure attribute of interdisciplinary knowledge network and relationship attribute of interdisciplinary knowledge elements. Details about specific indicator measurement mode are introduced as below.

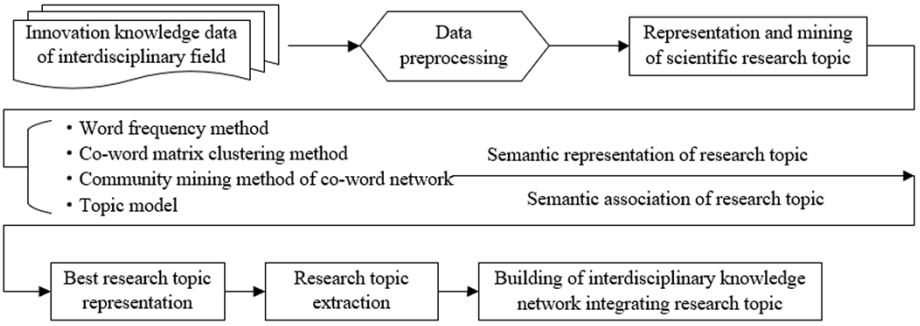

Fig. 1. Building process of interdisciplinary knowledge network

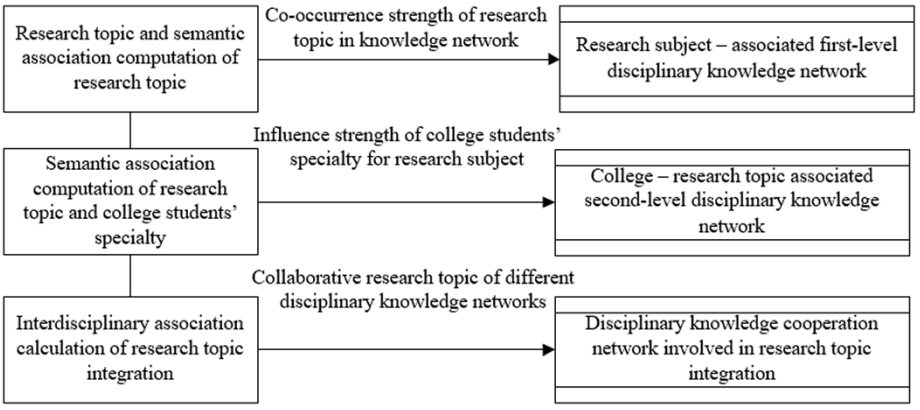

Fig. 2. Building process of interdisciplinary-dependent multilayer network

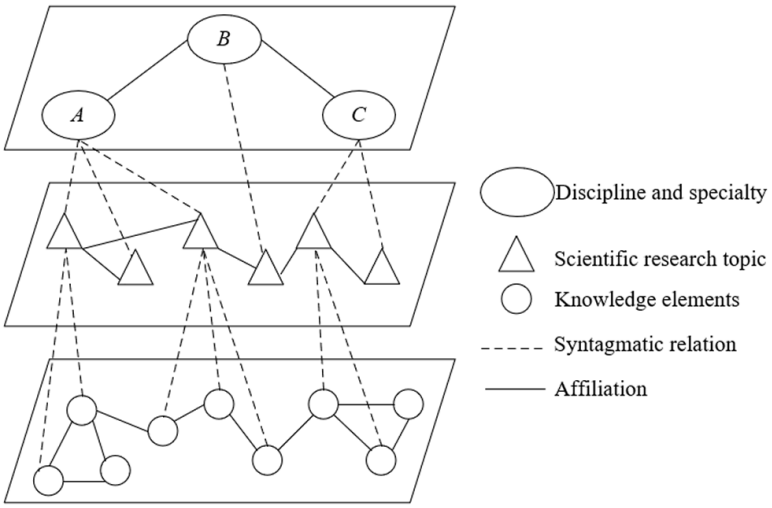

Fig. 3. Architecture of interdisciplinary-dependent multilayer network

Suppose the number of knowledge elements in interdisciplinary knowledge network is expressed as m_e, single disciplinary network as v and year as p, the diversity of interdisciplinary knowledge network is measured based on total number of knowledge elements and the calculation formula is as follows:

$$DI_{v,p} = m_e \tag{1}$$

To measure the uniqueness of interdisciplinary knowledge network, this article quantifies the uniqueness of single disciplinary knowledge elements first, i.e., calculating the number of knowledge element – linked single knowledge networks before superimposing the uniqueness of single disciplinary knowledge elements contained in interdisciplinary knowledge network. Suppose the number of knowledge element-linked single knowledge networks is expressed as m_v, knowledge element as e and year as p, the distinct quantitative formula of knowledge of single disciplinary knowledge network is shown as below:

$$KNUN_{e,p} = m_v \tag{2}$$

Suppose the interdisciplinary knowledge network is expressed as v, and the number of knowledge elements contained in interdisciplinary knowledge network as m_e, the distinct quantitative formula of interdisciplinary knowledge network is shown as below:

$$UN_{v,p} = -\sum_{e=1}^{m_e} KNUN_{e,p} \tag{3}$$

To obtain structural hole of built interdisciplinary knowledge network, the structure hole of various knowledge elements in single disciplinary knowledge network was calculated in this article, where the structural holes of all single disciplinary knowledge elements were superimposed. Suppose all points connected with node i are expressed as j, any node other than i or j as w, redundancy between node w and specific points i and j as $t_{iw}n_{jw}$ and the proportion of i and j links through node w in all i and j links as t_{iw}, the calculation formula of structural hole of single disciplinary knowledge element is shown as below:

$$KNSTH_{e,p} = \sum_{j}\left(1 - \sum_{w} t_{iw}n_{jw}\right) \tag{4}$$

The calculation formula of structural hole of interdisciplinary knowledge network is shown as below:

$$STH_{v,p} = \sum_{e=1}^{m_e} KNSTH_{e,p} \tag{5}$$

To obtain the centrality of built interdisciplinary knowledge network, the centrality of various knowledge elements in single disciplinary knowledge network was calculated in this article, where and the centrality of all single disciplinary knowledge elements was superimposed. Suppose the number of knowledge elements linked with knowledge elements of other single disciplinary knowledge network in single disciplinary knowledge network is expressed as M_l, the calculation formula of centrality of single disciplinary knowledge element is shown as below:

$$KNCE_{e,p} = M_l \tag{6}$$

The centrality calculation formula of interdisciplinary knowledge network is shown as below:

$$CE_{v,p} = \sum_{e=1}^{m_e} KNCE_{e,p} \tag{7}$$

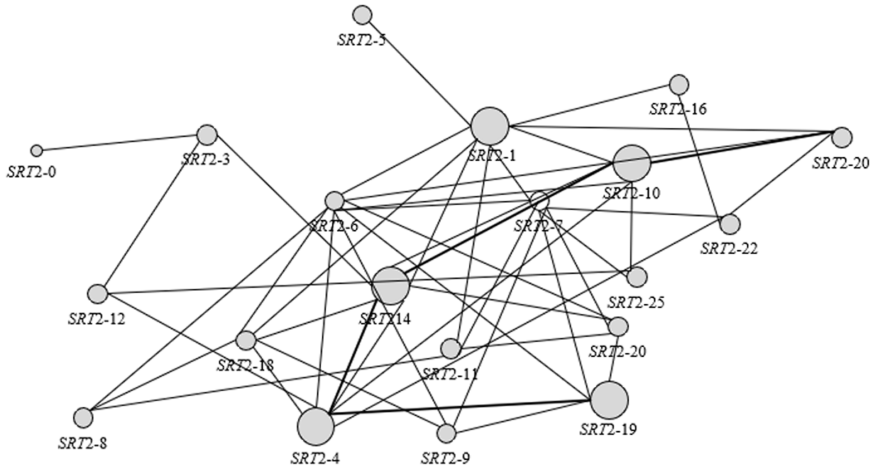

Fig. 4. Knowledge network diagram of research topic layer

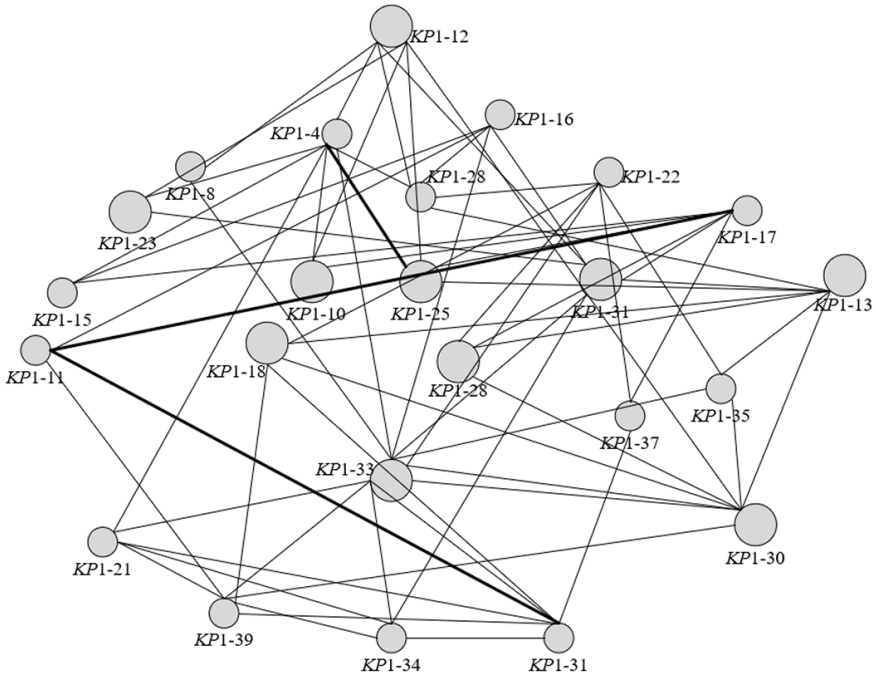

Fig. 5. Knowledge network diagram of knowledge element layer

Figures 4 and 5 show the knowledge network diagram of part of research topic layer and knowledge element layer. With an increasing number of college students participating in research activity, the number of research topics rises as well, and the existing interdisciplinary-dependent multilayer network becomes connected network; linkage

of college students' research topic with disciplinary knowledge of college students' specialty and other interdisciplinary knowledge is obviously strengthened. Figures 4 and 5 show strong tie of nodes in built interdisciplinary knowledge network and relatively important central nodes, and these research topic nodes and knowledge element nodes are also objects that college students need to concern intensively in research activity process. They're also popular research topic and promising research direction that college students need to consider intensively.

3 Direct influence of interdisciplinary knowledge network on college students' innovation ability

Descriptive statistics and correlation analysis in this article were conducted with Stata15.0 software. As verified by empirical result, the influence of diversity of interdisciplinary knowledge network on college students' technological innovation ability is of prominent inverted U-shaped form. The uniqueness, structural hole, expansion, and stability of disciplinary knowledge network exert significant positive influence on college students' innovation ability. Network centrality and structural hole of disciplinary knowledge of college students' specialty regulates the positive influence positively. Then robustness test was conducted and research results were discussed in this article.

This article's empirical research is divided into two steps. First, analyze the static characteristics of interdisciplinary knowledge network from such aspects of diversity, uniqueness, structural hole and centrality of interdisciplinary knowledge network. Then, analyze the dynamic characteristics of interdisciplinary knowledge network from expandability and stability of interdisciplinary knowledge network, and analyze the influence effect of static and dynamic characteristics of interdisciplinary knowledge network on college students' innovation ability. Last, analyze the regulating effect of location attribute of disciplinary knowledge network of college students' specialty in the relationship above.

Before carrying out regression analysis on the influence mechanism of interdisciplinary knowledge network for college students' innovation ability, first, verify the validity of random and fixed effect models with Horsman test. Dependent variable of this article is the number of college students' innovation achievements. The specific form includes patent, innovation and entrepreneurship competition award and investigation report; all the innovation achievements above are characterized by dispersion, noncontinuity, anticipation and variance inequality. Therefore, a negative binomial regression model was built in this article to analyze the influence of interdisciplinary knowledge network on college students' innovation ability. In the meantime, in consideration of unfixed duration of college students' research innovation process, and a long or short lag phase between innovation initiation period and achievements yield period, dependent variables in this article were made lagged behind for 1~2 years, i.e., the structural characteristic indicators of 2000–2022 interdisciplinary knowledge network corresponds to the number of innovation achievements of 2001–2022. Then, import variable data of 30 colleges and universities for nearly 20 years to Stata15.0, which are totally 2,472 groups of strongly balanced panel data.

The built regression model below is displayed, which is used for exploring the direct influence mechanism of dynamic and static characteristics of interdisciplinary knowledge network on college students' innovation ability. Suppose the number of college students' innovation achievements is expressed as *T*, score of college students' professional course as *HCt*, the number of college students' professional courses as *TE* and the number of innovation activity in which college students participate in is expressed as *CY*, the model formula can be expressed as below:

$$SD(T_{i,p}) = \beta_{i,p} b + \gamma_1 HCt_{i,p-2} + \gamma_2 TE \log b_{i,t-2} + \gamma_3 CY_{i,p-2} + \rho_{i,t} \tag{8}$$

Suppose the three control variables are expressed as *CV*, the constant of intercept term as $\beta_{i,p}$, residual term as $\rho_{i,p}$ and diversity of interdisciplinary knowledge network as *DI*, the model formula can be expressed as below:

$$\text{Model 2: } SD(T_{i,p}) = \beta_{i,t} + \gamma_1 CV_{i,p-2} + \gamma_2 DI_{i,p-2} + \rho_{i,p} \tag{9}$$

Suppose the quadratic term of interdisciplinary knowledge network is expressed as DI^2, the model expression formula will be expressed as follows:

$$SD(T_{i,p}) = \beta_{i,t} + \gamma_1 CV_{i,p-2} + \gamma_2 DI_{i,p-2} + \gamma_3 DI_{i,p-2}{}^2 + \rho_{i,p} \tag{10}$$

If γ_2 in the formula above is greater than 0 and significant and γ_3 is less than 0 and significant, it can be believed that the diversity of interdisciplinary knowledge network exerts influence in inverted U-shaped form on college students' innovation ability, i.e., when the diversity of interdisciplinary knowledge is relatively low, college students' innovation ability will increase with improvement of diversity of interdisciplinary knowledge network. But when the quantized value of interdisciplinary knowledge diversity exceeds threshold value, diversity of interdisciplinary knowledge network will restrain college students' collaborative innovation with professional knowledge learnt and other disciplinary professional knowledge, and lower college students' innovation ability. Suppose the uniqueness of interdisciplinary knowledge network is expressed as *UN*, the model formula can be expressed as below:

$$SD(T_{i,p}) = \beta_{i,p} + \gamma_1 CV_{i,p-2} + \gamma_2 DI_{i,p-2} + \gamma_3 DI_{i,p-2}{}^2 + \rho_{i,p} \tag{11}$$

If γ_2 in the formula above is greater than 0 and significant, it can be believed that the uniqueness of interdisciplinary knowledge network has great positive influence on college students' innovation ability, i.e., the higher the uniqueness of knowledge elements contained in interdisciplinary knowledge network is, the more beneficial it is to college students' collaborative innovation with professional knowledge learnt and other interdisciplinary knowledge, and to improve college students' innovation ability. Suppose the structural hole of interdisciplinary knowledge network is expressed as *STHO*, the model formula can be expressed as below:

$$SD(T_{i,p}) = \beta_{i,p} + \gamma_1 CV_{i,p-2} + \gamma_2 STHO_{i,p-2} + \rho_{i,p} \tag{12}$$

If γ_2 in the formula above is greater than 0 and significant, it can be believed that the structural hole of interdisciplinary knowledge network has great positive influence on college students' innovation ability, i.e., the higher the structural hole of knowledge elements contained in interdisciplinary knowledge network is, the more beneficial it is to college students' collaborative innovation with professional knowledge learnt and other interdisciplinary knowledge, and to improve college students' innovation ability. Suppose the centrality of interdisciplinary knowledge network is expressed as *CE*, the model formula can be expressed as below:

$$SD(T_{i,p}) = \beta_{i,p} + \gamma_1 CV_{i,p-2} + \gamma_2 CE_{i,p-2} + \rho_{i,p} \tag{13}$$

If γ_2 in the formula above is greater than 0 and significant, it can be believed that the centrality of interdisciplinary knowledge network has great positive influence on college students' innovation ability, i.e., the higher the centrality of knowledge elements contained in interdisciplinary knowledge network is, the more beneficial it is to college students' collaborative innovation with professional knowledge learnt and other interdisciplinary knowledge, and to improve college students' innovation ability. Suppose the expansion of interdisciplinary knowledge network is expressed as *EX*, the model formula can be expressed as below:

$$SD(T_{i,p}) = \beta_{i,p} + \gamma_1 CV_{i,p-2} + \gamma_2 EX_{i,p-2} + \rho_{i,p} \tag{14}$$

If γ_2 in the formula above is greater than 0 and significant, it can be believed that the expansion of interdisciplinary knowledge network has great positive influence on college students' innovation ability, i.e., the stronger the expansivity of interdisciplinary knowledge network is, the more the heterogeneous knowledge able to be provided for college students for their technological innovation and the higher the possibility of college students implementing collaborative innovation with professional knowledge learnt and other interdisciplinary knowledge, which is in favor of improving college students' innovation ability. Suppose the stabilization of interdisciplinary knowledge network is expressed as *ST*, the model formula can be expressed as below:

$$SD(T_{i,p}) = \beta_{i,p} + \gamma_1 CV_{i,p-2} + \gamma_2 ST_{i,p-2} + \rho_{i,p} \tag{15}$$

If γ_2 in the formula above is greater than 0 and significant, it can be believed that the stabilization of interdisciplinary knowledge network has positive influence on college students' innovation ability, i.e., the higher the stabilization of interdisciplinary knowledge network is, the higher efficiency college students' innovation will be under more scientific knowledge system, which is in favor of college students' collaborative innovation with professional knowledge learnt and other interdisciplinary knowledge and improvement of their innovation ability.

4 Regulating effect inspection of disciplinary knowledge network of college students' specialty

The following regression model was built in this article, in order to verify regulating effect of location attribute of disciplinary knowledge network of college students' specialty in influence relationship between interdisciplinary knowledge network and college students' innovation. The model below is built for the positive regulating effect of centrality and structural hole of disciplinary knowledge of college students' specialty in relationship between interdisciplinary knowledge network and college students' specialty. Suppose the centrality of disciplinary knowledge network of college students' specialty is expressed as *ARCE*, the model formula can be expressed as below:

$$\begin{aligned} SD(T_{i,p}) = \beta_{i,p} + \gamma_1 CV_{i,p-2} + \gamma_2 DI_{i,p-2} + \gamma_3 DI_{i,p-2}{}^2 + \gamma_4 DI_{i,p-2} * ARCE_{i,p-2} \\ + \gamma_5 DI_{i,p-2}{}^2 * ARCE_{i,p-2} + \gamma_6 ARCE_{i,p-2} + \rho_{i,p} \end{aligned} \tag{16}$$

If γ_4 in the formula above is greater than 0 and significant, it can be believed that centrality of disciplinary knowledge network of college students' specialty has regulating effect in the influence of diversity of interdisciplinary knowledge network on college students' innovation ability, i.e., when the area of disciplinary knowledge network of college students' specialty is at central position of interdisciplinary knowledge network, positive influence of diversity of interdisciplinary knowledge network on college students' innovation ability will be significantly enhanced. Suppose the structural hole of disciplinary knowledge network of college students' specialty is expressed as *ARSTHO*, the model formula can be expressed as below:

$$\begin{aligned} SD(T_{i,p}) = \beta_{i,p} + \gamma_1 CV_{i,p-2} + \gamma_2 DI_{i,p-2} + \gamma_3 DI_{i,p-2}{}^2 + \gamma_4 DI_{i,p-2} * ARSTH_{i,p-2} \\ + \gamma_5 DI_{i,p-2}{}^2 * ARSTH_{i,p-2} + \gamma_6 ARSTH_{i,p-2} + \rho_{i,p} \end{aligned} \tag{17}$$

where γ_4 in the formula above is greater than 0 and significant, it can be believed that the structural hole of disciplinary knowledge network of college students' specialty has positive regulating effect in the influence of diversity of interdisciplinary knowledge network on college students' innovation ability, i.e., when the disciplinary knowledge network of college students' specialty is at structural hole location of interdisciplinary knowledge network, positive influence of diversity of interdisciplinary knowledge network on college students' innovation ability will be significantly enhanced.

$$\begin{aligned} SD(T_{i,p}) = \beta_{i,p} + \gamma_1 CV_{i,p-2} + \gamma_2 UN_{i,p-2} \\ + \gamma_3 UN_{i,p-2} * ARCE_{i,p-2} + \gamma_4 ARCE_{i,p-2} + \rho_{i,p} \end{aligned} \tag{18}$$

If γ_3 in the formula above is 0 and significant, it can be believed that the centrality of disciplinary knowledge network of college students' specialty has positive regulating effect in the influence of uniqueness of interdisciplinary knowledge network on college students' innovation ability, i.e., when the disciplinary knowledge network of college students' specialty is at central position of interdisciplinary knowledge network, the positive influence of uniqueness of interdisciplinary knowledge network on college students' innovation ability will be significantly enhanced.

$$SD(T_{i,p}) = \beta_{i,p} + \gamma_1 CV_{i,p-2} + \gamma_2 UN_{i,p-2} + \gamma_3 UN_{i,p-2} * ARSTH_{i,p-2} + \gamma_4 ARSTH_{i,p-2} + \rho_{i,p} \quad (19)$$

where γ_3 in the formula above is greater than 0 and significant, it can be believed that the structural hole of disciplinary knowledge network of college students' specialty has positive regulating effect in the influence of uniqueness of interdisciplinary knowledge network on college students' innovation ability, i.e., when the disciplinary knowledge network of college students' specialty is at structural hole position of interdisciplinary knowledge network, the positive influence of uniqueness of interdisciplinary knowledge network on college students' innovation ability will be significantly enhanced.

5 Experimental results and analysis

Table 1. Inspection result of the influence of interdisciplinary knowledge network on college students' innovation ability

Model No.	1	2	3	4	5
Constant Term	31.252***	39.217**	6.241	25.629	158.324**
Number of college students' professional courses	0.025**	0.036***	0.027**	0.069***	0.024***
Score of college students' professional course	–0.047***	–0.061**	–0.014**	–0.058*	–0.017**
Number of college students participating in innovation abilities	4.185**	4.629***	4.384**	4.025*	4.629***
Diversity		–12.528**	52.637**		
Diversity^2			–36.928		
Uniqueness				1.257**	
Structural Hole					25.174*
Centrality					
Expansion					
Stabilization					
R^2	0.625	0.614	0.693	0.685	0.622
Regulating R^2	0.618	0.631	0.647	0.628	0.631
F value	425.182	369.325	311.274	359.628	300.425
N	1528	1169	1748	1253	1958

Note: ***, ** and * respectively indicate that they passed the significance test at the level of 1%, 5% and 10%.

Table 1 shows the inspection result of the influence of interdisciplinary knowledge network on college students' innovation ability. As shown by the table, monomial term of interdisciplinary knowledge network has significant positive influence on college students' innovation ability and diversity square of interdisciplinary knowledge network has significant negative influence on college students' innovation ability, which verifies the inverted U-shaped relationship between interdisciplinary knowledge diversity and college students' innovation ability. Uniqueness and structural hole of interdisciplinary

knowledge network have significant positive influence on college students' innovation ability and centrality of interdisciplinary knowledge network has negative but non-distinctive influence on college students' innovation ability. Both expansion and stabilization of interdisciplinary knowledge network have significant positive influence on college students' innovation ability.

Dependent variable put forward in this article is college students' innovation ability, and then indicators of dynamic and static characteristics of interdisciplinary knowledge network serve as independent variables, to build an analysis model. Table 2 summarizes the regression coefficient of interdisciplinary knowledge network and college students' different types of innovation abilities. As known from the table, the selected characteristic indicators affect college students' innovation ability dramatically. In addition, structural hole and centrality of disciplinary knowledge network of college students' specialty and regression coefficient of college students' innovation ability are greater than 0.5, verifying that disciplinary knowledge network of college students' specialty has definite regulating effect in the influence of interdisciplinary knowledge network on college students' innovation ability.

Table 2. Regression coefficient of interdisciplinary knowledge network with college students' different types of innovation abilities

Innovation Ability Category	**Progressive**		**Breakthrough**	
Model No.	1	2	1	2
Diversity	0.328**	0.167***	0.269**	0.085***
Diversity^2	0.469***	0.215*	0.316***	0.267*
Uniqueness	0.219**	0.185***	0.169**	0.012
Structural Hole	0.364***	0.027*	0.366**	0.168***
Centrality	–	0.529**	–	0.129
Expansion	–	0.751*	–	0.537***
R^2	0.128	0.469**	0.195	0.419
Regulating R^2	0.162	0.327*	0.138	0.405
F value	12.384**	25.169**	7.169**	22.142**
DW value	–	1.274	–	1.036
Innovation Ability Category	**Auxiliary**		**Complementary**	
Model No.	1	2	1	2
Diversity	0.129**	0.036	0.182***	0.002
Diversity^2	0.352**	0.149***	0.214	0.165
Uniqueness	0.196***	0.042	0.368**	0.195**
Structural Hole	0.015	0.147	0.411**	0.315*
Centrality	–	0.427*	–	0.237**
Expansion	–	0.362***	–	0.437
R^2	0.069	0.517	0.069	0.319
Regulating R^2	0.082	0.569	0.021	0.385
F value	3.247***	35.217**	3.528***	22.619*
DW value	–	1.069	–	2.374

Note: ***, ** and * respectively indicate that they passed the significance test at the level of 1%, 5% and 10%.

Table 3 summarizes regression coefficient among different types of innovation abilities. First, this article uses college students' auxiliary innovation ability and progressive innovation ability as dependent and independent variables for relevant experiment, and then, inspect the influence of dynamic and static characteristics of interdisciplinary knowledge network. After that, this article uses college students' complementary innovation capability and breakthrough innovation ability as dependent and independent variables for relevant experiment, and then, inspects the influence of dynamic and static characteristics of interdisciplinary knowledge network. The inspection result is shown by Table 3. According to the table, dynamic and static characteristics of interdisciplinary knowledge network have positive influence on college students' different types of innovation ability, verifying that all assumptions of built model conform to actualities.

Table 3. Regression coefficient among different types of innovation abilities

Group	**Auxiliary and Progressive**		
Model No.	1	2	3
Diversity	0.362*	0.162***	0.137**
Diversity^2	0.419***	0.285*	0.219
Uniqueness	–	0.512**	–0.003
Structural Hole	–	0.709***	0.254*
Centrality			
Expansion	–	–	0.369***
R^2	0.127	0.436	0.425
Regulating R^2	0.136	0.318	0.436
F value	15.269**	26.351***	20.692**
DW value	–	–	1.426
Group	**Complementary and Breakthrough**		
Model No.	1	2	3
Diversity	0.274**	0.069***	0.061
Diversity^2	0.392***	0.269**	0.131
Uniqueness	–	0.167	0.028
Structural Hole	–	5.629**	0.395**
Centrality			
Expansion	–	–	0.211***
R^2	0.152	0.436	0.438
Regulating R^2	0.119	0.485	0.402
F value	7.629**	26.395***	22.629*
DW value	–	–	2.013

Note: ***, ** and * respectively indicate that they passed the significance test at the level of 1%, 5% and 10%.

6 Conclusion

The influence mechanism of structural characteristics of interdisciplinary knowledge network on college students' innovation ability was studied in this article, where an interdisciplinary-dependent multilayer network was built and network nodes were divided into interdisciplinary knowledge element, research topic and discipline and specialty. Structure attribute of interdisciplinary knowledge network and relationship attribute of interdisciplinary knowledge elements were used to calculate indicators at different knowledge dimensions, and a specific indicator measurement mode was proposed. A regression model was built to explore direct influence mechanism of dynamic and static characteristics of interdisciplinary knowledge network on college students' innovation ability. By combining experiment, this article summarizes the indicators of interdisciplinary knowledge network at different dimensions. According to results, hot research topic, hot specialty or key knowledge elements that have bridge and link function in research activity can be judged effectively only by combining dynamic and static characteristics of interdisciplinary knowledge network with network node, and these important nodes have important effect on improving college students' innovation ability and promoting students to yield research results. The article further analyzes the influence of interdisciplinary knowledge network on college students' innovation ability and gives regression coefficient of interdisciplinary knowledge network and college students' different types of innovation ability. As known by experimental results, dynamic and static characteristics of interdisciplinary knowledge network have positive influence on college students' different types of innovation abilities, verifying that all assumptions of built model conform to actualities.

7 References

[1] Zharkimbekova, A., Ospanova, A., Sagindykov, K., Kokkoz, M. (2020). Implementation and commercialization of the results of the "multidisciplinary mobile computer class-room based on Raspberry Pi" project. International Journal of Emerging Technologies in Learning, 15(13): 116–136. https://doi.org/10.3991/ijet.v15i13.14665

[2] Mao, J., Wang, S., Shang, X. (2020). Investigating interdisciplinary knowledge flow from the content perspective of citances. EEKE 2020 – Workshop on Extraction and Evaluation of Knowledge Entities from Scientific Documents, 40–44.

[3] Delina, L.L. (2020). Potentials and critiques of building a Southeast Asian interdisciplinary knowledge community on critical geoengineering studies. Climatic Change, 163(2): 973–987. https://doi.org/10.1007/s10584-020-02921-0

[4] Nuankaew, P., Nuankaew, W., Teeraputon, D., Phanniphong, K., Bussaman, S. (2020). Prediction model of student achievement in business computer disciplines. International Journal of Emerging Technologies in Learning, 15(20): 160–181. https://doi.org/10.3991/ijet.v15i20.15273

[5] Steed, J.T., Gair, A. (2020). Enhancing 21st century interdisciplinary design skills within higher education through knowledge transfer partnerships. In DS 104: Proceedings of the 22nd International Conference on Engineering and Product Design Education (E&PDE 2020), VIA Design, VIA University in Herning, Denmark. https://doi.org/10.35199/EPDE.2020.1

[6] Fořt, J., Černý, R. (2022). Limited interdisciplinary knowledge transfer as a missing link for sustainable building retrofits in the residential sector. Journal of Cleaner Production, 343: 131079. https://doi.org/10.1016/j.jclepro.2022.131079

[7] Field, A. (2022). Mining the ambient commons: Building interdisciplinary connections between environmental knowledge, AI and creative practice research. Interdisciplinary Science Reviews, 47(2): 185–198. https://doi.org/10.1080/03080188.2022.2036408

[8] Wang, S., Mao, J., Lu, K., Cao, Y., Li, G. (2021). Understanding interdisciplinary knowledge integration through citance analysis: A case study on eHealth. Journal of Informetrics, 15(4): 101214. https://doi.org/10.1016/j.joi.2021.101214

[9] Shi, Y., Wang, Y. (2022). Research on the rules of scientists' knowledge sharing based on interdisciplinary measurement. Procedia Computer Science, 199: 657–664. https://doi.org/10.1016/j.procs.2022.01.081

[10] Díaz-Nafría, J.M., Muñóz-Montoro, A.J., Seoane, I., Bravo-Agapito, J., Chroust, G., Stavrakis, M., Guarda, T. (2021). glossaLAB: Enabling the co-creation of interdisciplinary knowledge through the reviving of long-term conceptual elucidation. In International Conference on Advanced Research in Technologies, Information, Innovation and Sustainability, La Libertad, Ecuador, pp. 18–33. https://doi.org/10.1007/978-3-030-90241-4_2

[11] Huang, Y., Glanzel, W., Thijs, B., Zhang, L. (2021). A framework for measuring the knowledge diffusion impact of interdisciplinary research. In 18th International Conference on Scientometrics & Informetrics (ISSI2021), Electr Network, Ku Leuven, pp. 533–538.

[12] Dredd, D., Kellam, N., Jayasuriya, S. (2021, October). Zen and the art of STEAM: Student knowledge and experiences in interdisciplinary and traditional engineering capstone experiences. In 2021 IEEE Frontiers in Education Conference (FIE), Lincoln, NE, USA, pp. 1–9. https://doi.org/10.1109/FIE49875.2021.9637284

[13] Jiang, J., Wang, X., Luo, X. (2020). Interdisciplinary knowledge-based implicit emotion recognition. Concurrency and Computation: Practice and Experience, 32(22): e5838. https://doi.org/10.1002/cpe.5838

[14] Lin, K.Y. Huang, C. (2022). Ensemble learning applications in multiple industries: A review. Information Dynamics and Applications, 1(1): 44–58. https://doi.org/10.56578/ida010106

[15] Coombs, C., Hislop, D., Taneva, S.K., Barnard, S. (2020). The strategic impacts of intelligent automation for knowledge and service work: An interdisciplinary review. The Journal of Strategic Information Systems, 29(4): 101600. https://doi.org/10.1016/j.jsis.2020.101600

[16] Yang, Y., Liu, X., Gardella Jr, J.A. (2020). Effects of a professional development program on science teacher knowledge and practice, and student understanding of interdisciplinary science concepts. Journal of Research in Science Teaching, 57(7): 1028–1057. https://doi.org/10.1002/tea.21620

[17] Chiba, H., Berque, D. (2020). Computer science intersects humanities: Visualization projects for liberal arts undergraduate students through an interdisciplinary approach using software development skills and Japanese cultural knowledge. In International Conference on Human-Computer Interaction, Copenhagen, Denmark, pp. 31–41. https://doi.org/10.1007/978-3-030-50267-6_3

[18] Weerd, J.D., Tan, E., Stoyanov, S. (2017). Fostering interdisciplinary knowledge construction in computer-assisted collaborative concept mapping. In European Conference on Technology Enhanced Learning, Tallinn, Estonia, pp. 391–396. https://doi.org/10.1007/978-3-319-66610-5_32

[19] Baihai, Z. (2014). The construction of library interdisciplinary knowledge sharing service system. In 2014 11th International Conference on Service Systems and Service Management (ICSSSM), Beijing, China, pp. 1–4. https://doi.org/10.1109/ICSSSM.2014.6874033

[20] Smith, E.M., Boger, J. (2022). Better together: Promoting interdisciplinary research in assistive technology. Assistive Technology, 34(1): 1–1. https://doi.org/10.1080/10400435.2022.2047397

[21] He, T., Fu, W., Xu, J., Zhang, Z., Zhou, J., Yin, Y., Xie, Z. (2022). Discovering interdisciplinary research based on neural networks. Frontiers in Bioengineering and Biotechnology, 10: 908733. https://doi.org/10.3389/fbioe.2022.908733

8 Authors

Tiejian Zhang, male, graduated from Hebei Agricultural University majoring in Agricultural soil and water engineering and obtained a Ph.D. degree in engineering. He is the associate professor and master's tutor of Hebei Agricultural University, He is mainly engaged in the teaching and research of rural water pollution control and water remediation technology, and the principle and technology of non-point source pollution control. Email: cjztj@hebau.edu.cn

Lan Ma, female, graduated from Energy and Environmental Engineering of North China Electric Power University with a doctorate degree in engineering. Now she is a lecturer of Hebei Agricultural University, mainly engaged in teaching and research on sewage treatment and reuse, zero discharge of wastewater, garbage leachate treatment, water pollution control, etc. Email: malan@hebau.edu.cn

Junliang Liu, male, graduated from Harbin Institute of Technology majoring in environmental engineering and obtained a Ph.D. degree in engineering. He is the professor and doctoral supervisor of Hebei Agricultural University. He is mainly engaged in teaching and research on water conservation, rural water pollution control and water body restoration. Email: cjljl@hebau.edu.cn

Article submitted 2022-11-13. Resubmitted 2023-01-07. Final acceptance 2023-01-13. Final version published as submitted by the authors.