The Influence of Multi-dimensional Social Capital on Science and Technology Innovation Willingness of University Science and Engineering Teachers

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Abstract. As the key scientific and technological talents, the promotion of university teachers' willingness to innovate in science and technology plays an increas-ingly significant role in enhancing the comprehensive strength of universi-ties and promoting the construction of a powerful country in science and technology. This paper takes the science and engineering teachers of a high-level industry characteristic university directly under the Ministry of Education as the research object, and discusses the impact of social capital on university teachers' willingness to innovate in science and technology from three dimensions of structure, relationship and cognition. Using Stata 16.0 software to carry out benchmark model regression, the data results show that the three dimensions of social capital have a positive impact on the willing-ness to innovate in science and technology. Therefore, colleges and universities should pay more attention to strengthening the construction of teacher teams, strengthening the cooperation between schools and enterprises, and deepening scientific and technological exchanges and cooperation in promoting the management activities related to scientific and technological innovation of science and engineering teachers.

Keywords: Multi-dimensional social capital; Science & technology; Education.

1 Introduction

Social capital is an analytical tool that has attracted much attention in the academic research field of humanities and social sciences in recent years. Its emphasis on social network relations, reciprocal norms, trust and cooperation and other elements highly meets the governance needs of organizational collaborative innovation. This study focuses on the innovation willingness of university science and engineering teachers, explores the impact mechanism of multi-dimensional social capital and university science and engineering teachers' innovation willingness, implements the national strategy of rejuvenating the country through science and education, promotes the improvement of incentive methods for university teachers' scientific and technological innovation, and promotes the further development of university science and technology innovation ability.

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2 Theoretical basis and research hypothesis

2.1 The connotation and dimension of social capital

Pierre Bourdieu [1] first put forward the concept of "social capital", defined it as a persistent network formed by mutual acquiescence or recognition, which is an actual or potential collection of resources. Coleman J [2]and Ptnam [3] Extending on this basis, we think that social capital is a kind of behavior ability for collective interests, including three dimensions of social trust, social norms, and social network, which can promote cooperation and improve the effectiveness of society. In summary, the close relationship between social capital and social relations, social resource exchange, is the focus of attention in the study of social capital. Based on existing research, this paper defines social capital as individual or social capital Based on the sum of actual and potential resources embedded in the relationship network owned and available, social capital is divided into structural, relational and cognitive dimensions to carry out relevant research.

2.2 Willingness to innovate in science and technology

American scholar Zaltman[4]defined the willingness to innovate as a variable used to measure the acceptance of new things, new ideas and innovation by organizations or individuals. At present, the research on the overall willingness to innovate of organizations at home and abroad is relatively rich, integrating the individual perspective of employees and the overall perspective of organizations [5]. For example, in the relevant research on the influencing factors of innovation willingness, most scholars focus their research perspective on the internal and external factors of the organization. The impact of variables such as individual factors, organizational factors and job characteristics on individual innovation willingness has been confirmed [6]. In the relevant research that takes innovation willingness as an intermediary variable, innovation willingness is often regarded as an important pre-variable of innovation behavior and innovation performance [7]. However, in the study of individual innovation willingness, there are limitations of insufficient research objects and insufficient research perspectives. Therefore, to further play the important role of China's universities as the main force of national basic research and other major scientific and technological breakthroughs, and stimulate the vitality of university talents, it is necessary to study university teachers' scientific and technological innovation willingness from a more diverse perspective of internal and external organizations and individual university teachers.

2.3 Structured social capital and willingness to innovate

Structural social capital is mainly related to social networks. Social networks were first proposed by anthropologist R. Brown when he studied the structure theory to analyze the behavior norms of people in bounded organizations. Granovett divides the relationship of social networks into strong and weak ties. Strong ties are the basis of the relationship between individuals. Weak ties span different organizations, The information of both parties is different [8] The strong association network based on personal communication in colleges and universities can be used as cohesive social capital, which can provide informal information exchange between college teachers and strengthen communication and exchange between them through social relations

based on geographical development. Colleges and universities will connect teachers with different resources to form a kind of cohesive social capital, which can enhance the willingness of college teachers to innovate in science and technology. Based on the above analysis, this paper proposes the following assumptions:

H1: Structured social capital has a positive impact on the willingness of science and technology innovation of university science and engineering teachers.

2.4 Relational social capital and willingness to innovate in science and technology

Relational social capital is mainly related to social trust. Social trust is a definition that people express their expectations for certain events in the future [9]. Ke Jianglin et al. proposed in the study that the trust attitude towards others is a manifestation of willingness to take the risk of weakening the knowledge advantage. Only when the knowledge owner is willing to take the risk, can knowledge sharing be truly realized, so the knowledge owner is more willing to donate his own knowledge under the condition of mutual trust. In the state of trust, university teachers will reduce the hesitation and doubt when collecting other people's knowledge and expressing their own knowledge needs, reduce the prevention psychology, promote in-depth communication between each other, and realize the sharing of innovation resources. Based on the above analysis, this paper proposes the following assumptions:

H2: Relational social capital has a positive impact on science and technology innovation willingness of university science and engineering teachers.

2.5 Cognitive social capital and willingness to innovate in science and technology

Cognitive social capital is mainly related to social norms. Social norms are rules and standards that guide or limit the behavior of group members, to ensure the realization of group objectives and the consistency of group activities. Hooff et al. pointed out in the study that the higher the degree of identification of members with the goals and vision of their group, the more willing they are to share their knowledge in this group. Ke Jianglin et al. believed that under the role of the common vision, members think it is beneficial to share their knowledge with others, and at this time they will be more willing to donate their knowledge. A clear common vision can enhance cooperation among members and improve the appearance of members The level of mutual understanding. On the basis of mutual understanding and under the role of the principle of reciprocity, members are willing to make efforts for a common vision, which is mainly reflected in the exchange and sharing of innovative knowledge among university teachers. Based on the above analysis, this paper proposes the following assumptions:

H3: Cognitive social capital has a positive impact on science and technology innovation willingness of university science and engineering teachers.

3 Research design

3.1 Variable measurement and research sample

The scale of social capital in this study is adapted from the scale designed by Gu Qinxuan et al In the context of colleges and universities, the term is mainly reflected in the network relationship and characteristics between members of colleges and universities, the trust between teachers and students, the organizational trust between departments and institutions, the language, customs and values shared by colleges and universities, and the integration of structural capital, cognitive capital and relational capital. The scale of willingness to innovate in science and technology was adapted from the scale of innovation motivation created by Pan Jingzhou et al. and was localized. A total of 243 questionnaires were distributed, with 224 valid questionnaires, accounting for 92.7% of the returned questionnaires.

3.2 Reliability and validity test

Use SPSS 26.0 software to measure Cronbach's α the reliability of the coefficient measurement scale is 0.7 as the critical value. Figure 1 shows that the Cronbach's Alpha values of structural social capital, relational social capital, cognitive social capital, social capital and willingness to innovate in science and technology are all higher than the critical value of 0.7, which proves that the reliability of the measurement indicators in this study is high, the internal consistency of each item in the scale is high, and the data can be reliable and stable. KMO value and Bartlett sphericity test were carried out on the items in the questionnaire. The test results are shown in Figure 2. The KMO index of the sample is 0.885, and Bartlett sphericity test passed the significant level of 0.001, which proves that the research variables have good construction validity.

variable		Cronbach's Alpha	Number of items
social capital	Structured	0.904	3
	Cognitive	0.762	3
	Relational	0.771	4
Willingness to innovate tech		0.932	10
Total amount table		0.967	42

Fig. 1. Reliability test results

KMO sampling suitability quantity		0.885
Bartlett sphericity test	Approximate chi-square	2208.735
	freedom	210
	Significance	0.000

Fig. 2. KMO and Barrett test

3.3 Descriptive statistics and correlation analysis

This paper has carried out descriptive statistics and correlation analysis on various research variables, and the specific results are shown in Figure 3: (2) The mean value of the explained variable reached 4.221, indicating that the university teachers surveyed had a strong willingness to innovate in science and technology; (3) There was a significant correlation between the test variables. Structural, relational and cognitive social capital are significantly positively correlated with the willingness of science and technology innovation of university science and engineering teachers (r=0.504, r=0.506, r=0.607, p<0.01). H1, H2 and H3 have been preliminarily verified.

variable	average value	standard deviation	1	2	3	4
Structured	4.275	0.817	1			
Relational	4.260	0.681	.669**	1		
Cognitive	4.317	0.615	.553**	.741**	1	
Willingness	4.221	0.602	.504**	.506**	.607**	1

**. At 0.01 level (double tail), the correlation is significant.

Fig. 3. Mean value, standard deviation and correlation coefficient

Above all, specific method is below: (Figure 4)

$$p = P(Y = 1 \mid X) = \frac{1}{1 + e^{-(\alpha + \sum_{i=1}^{m} \beta_i x_i + q)}}$$

$$n\frac{p}{1-p} = \alpha + \sum_{i=1}^{m} \beta_i x_i + \varepsilon$$

Fig. 4. Research Method

4 Hypothesis test

4.1 Benchmark model regression

The fitting degree of the linear regression model is good, indicating that the calculation results can truly and reliably reflect the impact of structural social capital, relational social capital, and cognitive social capital on the willingness to innovate in science and technology; There is no multicollinearity among the three independent variables, and the VIF is all less than 5; The regression equation is significant, F=124.236, P<0.001, which means that at least one of the three independent variables can significantly affect the satisfaction of dependent variables; The result of regression analysis shows that structured social capital can significantly and positively

affect the willingness of science and technology innovation of university science and engineering teachers(β= 0.243,P<0.05)； Relational social capital can significantly and positively affect the willingness of science and technology innovation of university science and engineering teachers(β= 0.279,P<0.05);Cognitive social capital can significantly and positively affect the willingness of science and technology innovation of university science and engineering teachers(β= 0.443,P<0.05).Based on the regression data, the regression equation between variables is as follows: Willingness to innovate in science and technology=1.874+0.165 * structural social capital+0.266 * relational social capital+0.443 * cognitive social capital (Figure 5).

Model	Denormalization coefficient		Standardization coefficient	t	Significance	
	B	Standard error	Beta			VIF
(constant)	1.874	0.279		6.712	0.000	
Structured	0.165	0.058	0.243	2.828	0.000	1.660
Relational	0.266	0.091	0.279	2.722	0.000	2.680
Cognitive	0.443	0.092	0.471	4.836	0.000	2.145
	R^2				0.322	
	F				124.236	
	P				<0.001	

A. Dependent variable: willingness to innovate in science and technology

Fig. 5. Benchmark model regression

4.2 Robustness test

To test the robustness of the estimated results of the model in Figure 5, first, replace the Logit model with Tobit model, perform regression analysis on the original variables, and output the model (1-3). The specific data is shown in Figure 6. Referring to the existing research, the proxy variable is used to replace the scores of each dimension for regression analysis. The specific data is shown in Figure 7. Social capital and scores of each dimension have significant positive impact, and the significance and direction of impact are consistent with the data in Figure 6; The proxy variables of each dimension also have a positive impact, and the level of significance remains unchanged, so the research conclusions are relatively stable.

Structured social capital	0.511**（0.037）		
Relational social capital		0.567**（0.039）	
Cognitive social capital			0.531**（0.039）
constant	0.994**（0.162）	1.927**（0.134）	1.550**（0.156）
P	0.000***	0.000***	0.000***
T	17.275	13.996	14.376

Note: *** and ** represent the significance level of 1% and 5% respectively

Fig. 6. Benchmark reversion robustness test: replacement model

variable	Denormalization coefficient		Standardization coefficient	T	P	VIF	R^2
	B	Standard error	Beta				
constant	1.060	0.156	-	6.81	0.000***	-	0.316
Structured	0.300	0.042	0.286	7.04	0.000***	1.70	
Relational	0.242	0.057	0.215	4.24	0.000***	2.65	
Cognitive	0.162	0.047	0.151	3.41	0.001***	2.01	

Note: *** represents the significance level of 1%

Fig. 7. Benchmark reversion robustness test: proxy variables

5 Conclusions and suggestions

First, strengthen the construction of teacher teams and adjust the talent structure of colleges and universities. Adopt the method of "external introduction and internal training", scientifically and reasonably introduce high-quality and high-skilled talents from the outside, and select and cultivate talents within the university teachers' team to stimulate the vitality of the team and promote the improvement of teachers' willingness to innovate. Second, improve infrastructure construction and strengthen cooperation between schools and enterprises. The conditions of hardware facilities in colleges and universities limit the scope and ability of science and technology innovation of science and engineering teachers. The quality and quantity of partners that teachers can contact can affect teachers' innovation potential and competitiveness, while the relationship with related enterprises affects the introduction channel of hardware facilities in colleges and the quality and quantity of partners that teachers can contact. Colleges and universities can strengthen cooperation with enterprises, form an effective combination of "production, learning and research", deeply understand the market demand, and create conditions for teachers to enhance their willingness to innovate in science and technology. Third, deepen scientific and technological exchanges and cooperation and create a good atmosphere for scientific and technological innovation. On the one hand, as a typical knowledge-intensive organization, the level of knowledge sharing within colleges and universities is the key to stimulate the promotion of willingness to innovate in science and technology. Colleges and universities should improve the information exchange mechanism of teaching teams by enriching communication methods, building information platforms, and improving communication systems, encourage teachers of similar majors to communicate and promote effective learning cooperation. On the other hand, we should pay attention to building an international scientific and technological exchange platform, provide a diversified environment and comprehensive information for scientific and technological innovation, and strengthen the external social capital of colleges and universities.

References

[1] Bourdieu P,The Forms of Capital [M], New York: Greenwood Press,1986:241-258.

[2] Coleman J S.Foundations of Social Theory[M]Cambridge:Harvard University Press,1990:79-90.

[3] Putnam R D Leonard R,Nanetti R.Making Democracy Work:Civic Traditions in Modem Italy[M].PrincetonUniversity Press,1993:70-95.
[4] Zaltman G,Duncan R,Holbek J.Innovations and Organization[M].New York:John Wiley,1973,47.
[5] Wang Jinfeng, Yue Junju, Feng Lijie. Government support and innovation performance of latecomer enterprises -- theintermediary role of innovation willingness [J]. Research on Technology Economy and Management, 2019 (04): 122-128
[6] Su Yi, Wang Xue, Ou Zhonghui. Research on the impact of entrepreneurs' political connections on enterprises' willingness to innovate -- based on the adjusted two-path intermediary effect model [J]. Soft Science, 2021,35 (01): 68-74
[7] Armitage C J,Conner M.Efficacy of the theory ofplanned behavior:a meta-analytic review[J].BritishJournal Social Psychology,2001,40(4):471-499.
[8] Lai Boai Social network structure, social trust and Hani farmers' participation in the independent governance of terrace ecosystem [D]. Northwest Agricultural and Forestry University, 2020
[9] Gong Wenjuan, Yang Kang. Social trust and rural residents' environmental participation behavior -- also on the intermediary effect of community belonging [J]. Environmental Sociology, 2022,1 (02): 169-190+238-239