

The Mechanism of Knowledge Associated Integration of Interdisciplinary Research Team Based on Absorption Ability

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Abstract. Interdisciplinary research team (IDRT) to solve complex, major multidisciplinary problem, is an important organization form. Members thought fusion and multidisciplinary knowledge integration is the key of implementing interdisciplinary team sustainable competitive advantage. According to the theory of knowledge absorptive capacity, this paper has analyzed knowledge associated integration mechanism of interdisciplinary team. First, the paper analyses the characteristics of absorbing ability cognitive mediation, subject link together mechanism, dimension conversion mechanism and reciprocal decision mechanism. Second, this paper builds an absorption evolution model of knowledge associated integration of interdisciplinary research team. Finally, it simulates and analyzes the evolution characteristics of interdisciplinary team knowledge network, and proposes management strategy.

1 Introduction

Big science times, scientific and technological development tends to complex multidimensional characteristics. Solution of major problem of science and technology gradually change to mutual cooperation way. With collaborative innovation and use different knowledge resources, interdisciplinary research team becomes an important organizational form of knowledge production. Knowledge integration and thinking between the different disciplines is the key to achieve interdisciplinary team unique competitive advantage. Study on mechanism of knowledge associated integration put forward the management strategy, which has the important research meaning and value to promote team knowledge innovation elements effective integration and fusion depth and ultimately to serve the society and regional economic development.

Knowledge production activities in interdisciplinary research team can not be separated off member knowledge absorption. Knowledge absorption stimulate creative thinking is the foundation of knowledge innovation. Thinking associated with the knowledge integration is the effect of knowledge absorption. The action relationship and mechanism of the absorption capacity and knowledge associated integration is one of the hot research topics in recent years. But so far, to absorb the outside world knowledge, the thinking associated way of members with heterogeneity knowledge of the interdisciplinary team and the knowledge integration mechanism between different members are relatively shortage. Deep analysis knowledge associated integration mechanism of interdisciplinary research team based on the knowledge absorptive capacity theory provides some suggestions for interdisciplinary team management and development.

2 Connotation of knowledge associated integration of interdisciplinary research team

Interdisciplinary research team as a link to complexity science mission and technical problem, gather different disciplines knowledge resources advantages based on group cooperation with openness organization, which has the nature of discipline knowledge integration and fusion of cognitive thinking to comes true scientific research and knowledge innovation target [1]. Through the comprehensive perspective integration of different disciplines and fusion heterogeneity of thinking, interdisciplinary team makes use of interdepartmental and the interaction of the subject creative thinking to solve complex scientific problems involving multidisciplinary field.

Knowledge integration and thinking associated is the key to effective integration and fusion depth of interdisciplinary research team elements of innovation.

Interdisciplinary knowledge associated integration means the member with heterogeneity discipline knowledge on the basis of problem solving cognitive psychological mechanism screening and using the advantage of resources from their own internal and external knowledge element actively carry out interdisciplinary communication, learning and cooperative innovation of issues field. By knowledge selecting, links, and convergence points, then formed interdisciplinary teams new knowledge needed and realize the value of knowledge, which promotes individual cognition of interdisciplinary team member sustainable development [2]. There are two main clues in interdisciplinary knowledge associated integration, subject knowledge integration and creative thinking association. Knowledge integration accompanied knowledge acquisition, knowledge application and Knowledge transfer, which reflect interdisciplinary knowledge innovation activities creative, unpredictability and uncertainty. Thinking associated elaborates that individual cognitive development follows general psychological processes of problem solving. It contains analysis and characterization and generation and selection the solution scheme, implement and evaluate solution scheme. Subject knowledge integration and thinking associated are two interdependent and mutual promotion spiral sequence. The reciprocal action of multiple members thinking and disciplinary knowledge formation of knowledge network system, which finally resolves the problem achieve knowledge innovation. The members of interdisciplinary team keep absorption ability(including access, transformation and utilization) face to external knowledge, promotion knowledge open flow and high efficiency transfer, stimulation creativity thinking associated and subject knowledge integration, which improves the innovation and development ability of interdisciplinary team in the process. It is the key of the intermediate links to success of the interdisciplinary research.

3 Absorption mediation characteristic and evolution mechanism of interdisciplinary research team knowledge associated integration

Knowledge absorptive capacity referred to as absorption capacity. It put forward by Cohen and Levinthal in 1990. Knowledge absorptive capacity is defined as identifies new information on the outside and digest and application ability of an organization. It is a function of organization knowledge, which is crucial for the organizational innovation ability. The fact of science and technology development tells us that interdisciplinary team as a kind of social organizational system and social activities always attached to certain social environment. The individual knowledge absorptive capacity is regarded as team core starting point and cognitive mediation of knowledge production activities to guide the interdisciplinary research team knowledge associated integration and affects the multidisciplinary knowledge collaborative innovation. Characteristics of collaboration, series feedback and triadic theory are precondition of promotion interdisciplinary research team knowledge associated integration and stimulation creative thinking.

3.1. The collaborative features and subject link together mechanism of IDRT knowledge associated integration

Thinking associated and knowledge integration with absorption new knowledge is a microscopic behaviour, but also is the collaborative innovation between team members. Members are the basis of interdisciplinary knowledge innovation. Absorptive capacity of members is the foundation of the team absorptive capacity, but also is the innovation source of interdisciplinary team knowledge associated integration. It significantly embodies the highest level on organizational learning and member communication, promotion the access of unique information resource acquisition, transmission and application. It is the fundamental guarantee of interdisciplinary team knowledge innovation. Member knowledge absorptive capacity based on the absorptive capacity of team flexible uses and gives full expression to information and resources advantage on organize internal and external. On individual level, the individual of members through social networks set the resource network that can absorb the knowledge and technology. Available knowledge resources is assembled in the individual mind associated cognition then materialized knowledge and innovative behaviour. On team level, team absorptive ability based on the member absorptive capacity could realize the long term development and performance growth of the team organization. Therefore, knowledge absorption ability collaborative features make team and personal knowledge associated integration has the connected effect supplement each other. Personal effective exploration, transformation and utilization of knowledge promote directly individual and organization knowledge absorptive capacity growth and improvement of performance. In conclusion, knowledge absorptive capacity on team and members with "dual belong to one" attributes has subject link together mechanism. It then is able to realize that individual knowledge absorption- individual knowledge innovation team knowledge creation in spiral interactions on individual cognitive thinking and team knowledge innovation is spiral growth. It improves the efficiency of team knowledge collaborative innovation.

3.2 The continuous feedback characteristics and dimension conversion mechanism of IDRT knowledge associated integration

Absorbing ability closely related to organizational learning is a dynamic knowledge conversion process [3]. Absorbing ability not only depends on the prior knowledge but also enhance knowledge associated integration degree through the study of continuous feedback.

This paper takes example by Zahra and George dimensions of absorptive capacity, with cognitive psychology problem solving process perspective and the dynamic theory of knowledge innovation, and divides members of interdisciplinary team knowledge absorptive capacity into three continuous feedbacks dimensional of exploration, transformation and utilization [4]. On the one hand, knowledge absorptive capacity is the foundation of knowledge innovation, which provides knowledge coupling material and extension space for problem solving. Three dimensions are relatively independent and complement each other, move in circles and spiral, and change the members of the individual knowledge quantity and nature of knowledge to improve the interdisciplinary research innovation performance and innovation ability. On the other hand, these three kinds of ability is a process of the fuzzy knowledge discovery to become clear knowledge innovation. Cohesion exploration ability and utilization ability, transformation ability embodies subject knowledge integration and thinking associated with knowledge-based association rules. Exploring ability is the potential knowledge absorptive capacity, providing the breadth and depth of knowledge absorption of innovative individual. It reflects results expectations of absorbing knowledge. Use is real knowledge absorption ability reflects actual results to absorb the knowledge. It plays a direct role in promoting to individual knowledge innovation behaviour. The continuous feedback three dimensions characteristics of exploration, transformation and utilization knowledge ability, step by step excitation knowledge integration and thinking association, expand knowledge system space. Relative to the external knowledge, it also highlighted the explicit knowledge and tacit knowledge members of the innovation are equal importance. Individual cognitive mechanisms of assimilation and comply with stimulates interaction between knowledge and thinking. With transformation and fusion, knowledge grows up and be shared to other members absorption and recycling.

3.3 The ternary interaction characteristics and reciprocal decision mechanism of IDRT knowledge associated integration

Interdisciplinary research is a collective activity. The social cognitive ternary interaction theory tells us behaviour is combined action result of the cognition and environment. Knowledge absorption is a kind of people's cognitive activities. Knowledge integration and thinking associated is concrete behaviour caused by this kind of cognitive activity. This process constantly affected by the member environment.

The ternary interaction theory proposed by social cognitive scientist Bandura points out three reciprocal actions of environment, cognitive and behaviour, behaviour control by the cognitive and affected by the environment at the same time. Visibility, environment, main cognitive and behaviour are relatively independent as well as interdependent. The relationship of affects and restricts between them similarly external environment change individual cognition, individual cognitive change individual behaviour. Chini indicates human behaviour lead by rules of organization situation and social resources. The knowledge transferred by individual behaviour matches the receiving element situation needs [5]. Therefore, the reciprocal action on factors of knowledge, personality and environmental will affect member knowledge associated integration by influencing the members to absorb knowledge. In turn, knowledge associated integration feedback to promote adjustment various factors in the environment further influence member knowledge absorption. The ternary interaction theory has revealed the member knowledge absorptive capacity and knowledge associated integration and team setting has the mutual decision relationship. Interdisciplinary research team knowledge associated integration absorption mediation characteristic as shown in the Figure1.

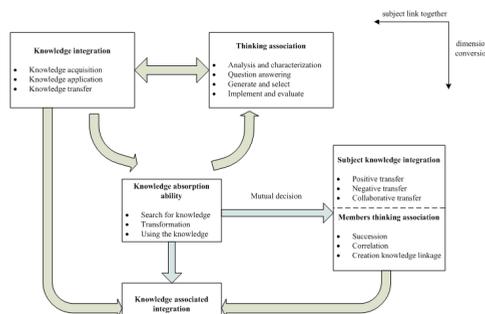


Fig.1. The absorption mediation characteristic of interdisciplinary research team knowledge associated integration.

4 The evolution model and analysis of absorption mediation characteristic of IDRT knowledge associated integration

Interdisciplinary knowledge associated integration contains two main threads subject knowledge integration and members thinking association. Knowledge absorption as a cognitive mediation plays connection function of macro knowledge and micro thinking. Knowledge integration including knowledge acquisition, knowledge application and

knowledge transfer gives expression to creative, uncertainty and unpredictability on interdisciplinary knowledge innovation activities.

Thinking associated elaborates individual cognitive development following general psychological process of problem solving, including the analysis and characterization of problem, trouble shooting, generation and selection the solution scheme, implement and evaluate solution scheme, with reflection cross discipline thinking starting, respectively, jumping, activation. Subject knowledge integration can be divided into positive transfer, negative transfer and collaborative transfer three types. Thinking associated includes the succession, correlation and creation knowledge linkage. Deep analysis of IDRT knowledge associated integration process is favour of improving the efficiency of team innovation.

4.1 The evolution model of absorption mediation characteristic of IDRT knowledge associated integration

4.1.1 Interdisciplinary research team knowledge system

Let $N = \{n_1, n_2, n_3, \dots, n_N\}$ denote a set of N knowledge points. At time t, if there is a directed edge from knowledge node j to node i , at time t, then expression node i can absorb knowledge discovered by agent j , $j \in N - \{i\}$. Therefore, all the directed edges $e_{i,j}$ make up a set of edges $E(t)$, $E(t) = \{e_{i,j} | i, j = 1, 2, \dots, N\}$. The collection on N and E , $G(t) = (N, E(t))$, represents the topology of collaborative knowledge innovation network under dynamic absorption. Knowledge absorption prompts knowledge point of individual cognitive distance smaller link and fusion. It then forms knowledge network and comes into being obvious influence on the network structure. Members knowledge absorptive capacity, subject knowledge distance, probability of knowledge integration affected by knowledge, probability of knowledge integration affected by the personality, it common effect innovation efficiency. Knowledge associated integration can use the following Eq. (1).

$$S = S_K + S_T = f_{(K,E,C,t)} + g_{(T,U,C,t)} \tag{1}$$

S is knowledge system of interdisciplinary research team. S_K is the interdisciplinary team discipline knowledge integration system. $f_{(K,E,C,t)}$ is the knowledge integration system. S_T is interdisciplinary research team member thinking association system. $g_{(T,U,C,t)}$ is the member thinking association system function. E is subject knowledge cross weight coefficient. $0 \leq E_{(i,j)} \leq 1$, Its value decided by subject function distance between the knowledge i and j. U is the knowledge absorptive capacity function. In normal conditions, knowledge i can't completely absorbed j. So the node i for the absorption coefficient of knowledge is random in the scope of [0, 1]. Knowledge absorptive capacity by causing high level knowledge overflow between members in the knowledge transfer process produces a dynamic effect on team innovation activities. The knowledge stock of members is continuously increasing along with the knowledge exchange and sharing activities. The higher knowledge updates speed, the greater knowledge depreciation. Therefore, set the maximum difference between absorption learning and knowledge depreciation is CU. Knowledge absorptive capacity function obeys uniform distribution between [0, CU]. K、T is a function of time t. C is the system state variables and is a constant.

4.1.2 Interdisciplinary research team discipline knowledge integration system

$$f_{(K,E,C,t)} = K_i(t) = E_{(i,j)} \cdot T_{i(t-1)} \cdot P_{K-j} + T_i(t) \tag{2}$$

Discipline knowledge integration system includes two parts. At time t, the $T_i(t)$ denotes the thinking increment of knowledge node i and absorption knowledge stock from its neighborhood node j, until time t-1, $E_{(i,j)} \cdot T_{i(t-1)} \cdot P_{K-j}$. $T_{i(t-1)}$ is the incremental thinking of nodes i, at time t-1. $E_{(i,j)}$ is subject knowledge cross weight coefficient. It has diminishing exponential relationship of subject function distance $d_{(i,j)}$. The smaller subject function distance, the closer the cognitive, the higher the efficiency of knowledge diffusion. The greater subject function distance, the lower the efficiency of knowledge diffusion, the slower the growth rate of knowledge. Considering the distant subjects' innovation is less likely, there is no cognition resonance and cooperative relationship. Subject distance $d_{(i,j)} \neq \infty$ is beyond the scope of consideration. The impact factor of subject knowledge distance lessens, along with cultural gap decrease. When the culture gap is very minimal, the practical significance of the integration innovation with comprehensive knowledge different subjects in interdisciplinary research is lose away. P_{K-j} is for the node j the affected

by the knowledge probability in Knowledge integration. Knowledge is mainly divided into explicit knowledge and tacit knowledge. In comparison with the theory and method, cutting-edge technology knowledge show more tacit knowledge. It can't make oneself master skill in a short period of time. The probability of knowledge effectively integrate is small. The wider is prior knowledge scope and difference, the easier is knowledge absorption. Knowledge accumulation and structure, knowledge expressiveness increase the chance to acquire knowledge. Knowledge heterogeneity and complexity increased the difficulty of communication and exchanges between scientific research personnel, which reduce the knowledge associated integration efficiency.

4.1.3 Interdisciplinary research team members thinking associated systems

$$g_{(T,U,C,t)} = T_i(t) = T_{i(t-1)} \cdot P_{T,j} + U_i \cdot K_{i(t-1)} \tag{3}$$

Member thinking associated systems describes implicit cognitive growth process of personal mental enlightenment. It consists of two parts. The existing association thinking on node *i*, at time *t-1*, is thinking associated incremental, $T_{i(t-1)} \cdot P_{T,j}$. And the stock of knowledge associated is $U_i \cdot K_{i(t-1)}$ from the absorption of other nodes at time *t-1*. $P_{T,j}$ is the probability of node *i* personality effect on node *i* absorption thinking *j*. Learning engagement of members of IDRT for the innovation practice is the power to explore knowledge. Everyone involved in the cooperation has some mental freedom and feeling of control is favor of cooperation innovation [6]. The rigor and complexity and occasionality of interdisciplinary research activities decide to study difficulty.

So the individual of the members has the good psychological quality and personality traits directly affect thinking associated integration efficiency. The courage to face difficulties, open innovation thinking, tolerance of trial and error, creative thinking, individual learning, outcome expectation, self assessment of the results and behavior, self efficacy and so on. Knowledge absorptive capacity function is U_i . Due to knowledge aging effect, knowledge absorptive capacity function obeys uniform distribution among $[0, CU]$.

4.2 The simulation analysis of IDRT knowledge associated integration evolution model

There are six nodes in an interdisciplinary research team. Each initial increment of the nodes, $T_i(t)$, randomly generated within the $[0,1]$ in the system. Under normal conditions, interdisciplinary is easier to produce major knowledge innovation. Subject knowledge cross weight coefficient is greater than knowledge absorptive capacity coefficient. $E_{(i,j)} > U_i$. In order to see each knowledge node quantity transformation, this paper combining with the coefficient values range set $E_{(i,j)} = 0.05$, $U_i = 0.01$. Regardless of the network nodes no path connected and knowledge type impact on the interdisciplinary innovation, it conducts the evolution simulation of knowledge associated integration mechanism. The simulation calculation realized by Matlab programme. In order to reduce the simulation result influence of the initial random data, all simulation models simulate 40 times. The results are shown in Figure2.

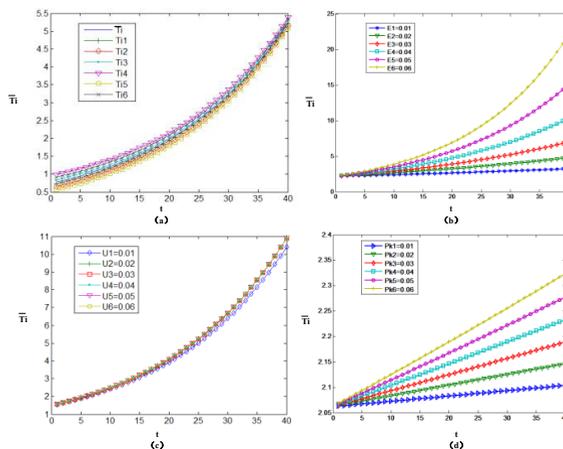


Fig.2. The simulation of IDRT knowledge associated integration.

4.2.1 The evolvement analysis of the network overall knowledge level ($\overline{T(t)}$)

The network overall knowledge level is measuring knowledge created by knowledge network over a period of time. It is average value of all the knowledge nodes in the network, Eq. (4).

$$\overline{T(t)} = \frac{1}{N} \sum_{i=1}^n T_i(t) \quad (4)$$

The evolution simulation of interdisciplinary team knowledge associated integration network see Figure2 (a) . The network overall knowledge level and each node incremental overall shows a trend of increasing over time. The growth rate of overall levels of knowledge reflects knowledge transfer speed. First, the network overall knowledge level gradually increase. After reached an extreme, it increases rapidly. This shows that a period of stage of discipline understanding and knowledge exchange between members in early interdisciplinary team building, because of discipline culture, logic and language disacquaintance [7-8]. The knowledge collaboration degree increases rapidly among members, when effective fusion of the acquisition knowledge and prior knowledge. Thinking association and knowledge integration happen frequently.

Knowledge is growing fast. Despite the initial values of different knowledge level, but growth trend is the same.

4.2.2 Analysis of the influence of discipline knowledge cross weight coefficient

Subject knowledge distance has nothing in common with each other within the interdisciplinary team. The smaller the subject knowledge distance, the greater the knowledge cross weight coefficient [9]. The greater knowledge innovation opportunities, the faster network overall knowledge promotion. Parameter is the same as set previously except discipline knowledge cross weight coefficient. The simulation result is Figure2 (b) . Upgrade discipline knowledge cross weight coefficient, innovation efficiency increases accordingly. This shows that the greater the chances of knowledge cross fusion with donor and receptor disciplines in the process of interdisciplinary research, the more prone to collaborative innovation and the faster the overall level of knowledge network improvement.

4.2.3 Analysis of the influence of knowledge absorption ability

Parameter is the same as set previously except knowledge absorption ability. The simulation result is Figure2 (c) . Team node has different knowledge absorptive capacity. The stronger absorption capacity, the faster network overall knowledge level promotion. Upgrade knowledge absorptive capacity, the overall level of knowledge network is a growing trend. Each ability level shows the characteristics of obvious differences on the whole intellectual growth. In the initial stage of the team, the effect was not significant with knowledge absorptive capacity on the whole knowledge growth. But when the team development to a certain stage the effect was more and more manifest with knowledge absorptive capacity on the whole knowledge growth. The stronger knowledge absorptive capacity, innovation ability, the overall knowledge enhancement is fast. Knowledge absorptive capacity is weak [10]. So the knowledge innovation growth is slower. The network overall knowledge level is significantly lower than the knowledge network the stronger knowledge absorptive capacity.

4.2.4 Analysis of the influence of probability of knowledge integration affected by knowledge

Other assumptions invariability, conditioning probability of knowledge integration affected by knowledge, analysis of the influence of the probability variation to the evolutionary character of the network overall knowledge level, the simulation is shown in Figure2 (d) . The probability of knowledge integration affected by knowledge is greater. The knowledge variation is more significant. That is to say the collaboration efficiency of a single node and other nodes depends on the knowledge flow type. The type of single, simple and explicit knowledge easy to transfer to make full use of knowledge, which affected by the type of knowledge small have no obvious effect on the network overall knowledge level. when there is heterogeneity discipline knowledge members to join, bring the flood of resource types of discipline theory, method and technique, the more knowledge type affected by the knowledge impact probability is bigger exerts significant influence on the network overall knowledge level.

5 Conclusion

Interdisciplinary team members' knowledge absorption ability, keep the absorption of external knowledge, including access, transformation and utilization, to promote knowledge open flow and high efficiency transfer [11]. It stimulates creative thinking and knowledge integration and is the work foundation of collaborative between team members. The knowledge absorptive capacity theory is introduced in interdisciplinary team knowledge associated integration mechanism. It reveals interdisciplinary team knowledge associated integration is precondition of giving full play to the team multidisciplinary knowledge advantages. First, the characteristic of cognitive mediation of absorptive capacity is analyzed in the interdisciplinary team knowledge associated integration process, subject link together mechanism, dimension conversion mechanism and reciprocal decision mechanism. Second, the evolution model of interdisciplinary team knowledge associated integration is constructed and the simulation analysis of the four evolutionary trend of interdisciplinary team knowledge network. In conclusion, interdisciplinary team members have the good psychological quality and personality characteristics, the courage to face difficulties, open innovation thinking, tolerance of trial and

error, creative thinking, individual learning, outcome expectation, self assessment of the results and behavior, self efficacy and so on, directly affect the thinking associated integration efficiency. With the team culture and common goal as the glue of interdisciplinary knowledge resources, interdisciplinary collaborative innovation practice can promote interdisciplinary team innovation performance in the system design to form under the dual role of interaction between team members (internal cause) and the external environment condition (external cause) to control the dynamic knowledge correlation integration process. It is in favor of team management work in the interdisciplinary.

Acknowledgement

This paper was supported by the National Natural Science Foundation of China (No.71473057) , the Jiangsu province Natural Science Foundation (No. BK20140345), the Natural Science Foundation of Young Teachers of Soochow University(No.SDY2015A06), the Jiangsu province Colleges and Universities Natural Science Foundation (No.14KJB460025), the National Science Foundation for Post-doctoral Scientists of China (No. 2014M551651) and the Jiangsu province Natural Science Foundation for Post-doctoral Scientists (No. 1401073C).

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