Research on the University Engineering Mentoring Team Cultivation of Knowledge Innovation

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Abstract: Tutorial system team of Emerging Engineering Education is science and technology innovation team of college engineering discipline mentor and the graduate. In order to solve complex problems as the goal, through effective knowledge absorption, correlation and integration, the team is knowledge innovation research organization. Through the analysis of mentoring new engineering team knowledge integrated model, this paper put forward knowledge innovation depend on the three phase of knowledge absorptive capacity. Using system dynamics method and the ternary determinism, a differential dynamic model of integrating knowledge connection between teachers and students is establishment. Analysis of the main parameters of knowledge absorptive capacity affecting the team members, the paper put forward to promote knowledge efficient sharing management advice inside the team from the perspective of strengthening the team process management.

1. Introduction

The level of engineering technology is the key to the country's social and economic development and strategic rejuvenation. The construction of engineering disciplines is the primary task of the development of colleges and universities in the new century. The direction of China's engineering education reform oriented to China's new international competition environment, new strategic demands, new requirements based on morality and cultivating talents (Emerging Engineering Education, 3E) has attracted extensive attention from scholars [1]. The new engineering construction has the characteristics of strategic, innovative, systematic and open [2]. To promote the construction of new engineering in a phased manner, it is necessary not only to focus on the three tasks of teaching, practice and innovation, entrepreneurship, localization and internationalization [3], but also to cultivate new types of engineering innovation talents with innovative thinking and practical ability.

The mentoring team that solves real-world engineering problems is the main force in cultivating innovative talents in new engineering. The new engineering tutor system is not only the basic unit for cultivating talents in universities, but also the key scientific research organization for scientific and technological innovation in universities. As the first person responsible for postgraduate training, the instructor often pays more attention to cultivating students' new literacy, sense of space, relevance, imagination, macro thinking and critical thinking [4], and has new knowledge from professional courses and knowledge systems. The ability of the structure to propose new ways to adapt to new engineering teaching and learning with the introduction of clues in project tasks. In the process of knowledge linking and sharing among team members, the possibility of emerging or forming or about to form emerging engineering disciplines, fields or directions is more significant [5]. The typical characteristics of emerging disciplines or fields are novel, representing new developments in engineering and technology, closely linked to fast-growing industries and the new economy, and containing some uncertainty or ambiguity [6]. The knowledge relationship between the

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tutor and the student is a transitional process from follow-up to parallel. Students need to gradually adapt to some unclear, uncertain, and even temporarily incorrect understanding and understanding in the process of being led. The new knowledge production process and the improvement of innovation efficiency through management means are worthy of attention.

The relevant researches of the existing engineering instructor team mainly focus on the meaning connotation, team management mechanism, influencing factors, etc. [7-9], lacking the essence of the knowledge innovation training (knowledge point fast link communication) for the tutor system Analysis and discussion. The generation of new engineering knowledge comes from the integration and generation of knowledge points. This process interacts with the three major factors of innovation engineering projects, team innovation environment, member cognition and member innovation behavior. In summary, based on the ternary interactive logic relationship, the research group analyzes the knowledge innovation training process of the new engineering tutor system from the perspective of the progressive knowledge linkage of knowledge exploration, transformation and utilization, and proposes from the perspective of strengthening team process management. Management suggestions that promote the efficient sharing of knowledge within the team will help solve practical engineering design problems, foster graduates' innovative and entrepreneurial abilities, and core skills and professional attitudes involved in the profession.

2. The knowledge innovation training mode of the new engineering tutor system team

The knowledge innovation training of the new engineering tutor system is not only a kind of micro-cognitive reconstruction behavior, but also guided by organizational situation rules and social resources. Social cognition expert Bandura pointed out that behavior is subject to cognitive control and is also affected by the environment [10-11]. The external environment changes individual cognition, adjusts individual behavior, and the environment (E), cognition (P) and behavior (B) are relatively independent and interdependent. In the project team composed of graduate tutors and students, the knowledge transfer behavior needs to match the recipient's situational needs. In the “three-way interaction” relationship of the innovation team PEB, any relevant factor changes will have a physiological and psychological impact on the team members, and promote or restrict the team development. Therefore, the cultivation of knowledge innovation not only focuses on knowledge integration, but also on the integration of cognitive thinking. It also takes into account the impact of the innovation environment. Knowledge integration and thinking linkage are the key to the success of the new engineering tutor system.

On the one hand, knowledge innovation training is influenced by knowledge factors (knowledge integration), subject factors (thinking relationship) and cooperation factors (knowledge absorption ability); on the other hand, knowledge factors provide the driving force for knowledge innovation training, subject factors regulate individual cognition and cooperation Factors provide important support for the cultivation of knowledge innovation. When the innovation environment promotes knowledge integration, cooperation factors will positively affect knowledge absorption capacity and accelerate knowledge transformation and application. Conversely, if the innovation environment inhibits knowledge integration, cooperation factors will negatively affect knowledge absorption capacity and reduce the efficiency of knowledge absorption and application. In summary, knowledge integration is determined by knowledge factors, which is the dynamic basis of knowledge innovation training behavior; thinking association has different characteristics, and is strongly related to innovative individual personality characteristics, from subject factors to cognitive adjustment; knowledge absorption ability is explored by knowledge The three stages of knowledge transformation and knowledge utilization are cyclical reciprocal spiral propulsion [12], which is influenced by the cooperative innovation environment. The PEB “Ternary Interactive” elements of knowledge-based innovation are interacting. Knowledge innovation training is a ternary combination of personnel attributes, knowledge attributes and cooperation attributes. The change of any attribute elements and their interaction will change the occurrence state of collaborative innovation activities. The three influencing factors of knowledge factor, subjective factor and cooperation factor respectively lead the new engineering instructor team members to change in knowledge integration, thinking connection and knowledge absorption ability, and jointly play on knowledge innovation to cultivate "innovation field", which in turn affects team knowledge innovation effectiveness. Knowledge factor is the driving force for the cultivation of knowledge innovation. The main factor plays the role of cognitive regulation and cooperation. It is an important supporting condition for the cultivation of knowledge innovation. They affect the knowledge innovation and cultivation behavior by acting on knowledge integration, thinking connection and knowledge absorption ability. The cooperation factor has a direct and profound impact on the team's innovation behavior through the member's knowledge absorption ability. Therefore, the research team starts from the key link of knowledge absorption ability and proposes an analysis of the new engineering tutor system knowledge innovation training process.

3. Analysis of Knowledge Innovation Training Model of New Engineering Tutor System Team

We believe that knowledge can be divided into several small knowledge points. Knowledge points can be regarded as the basic unit of knowledge. In order for the knowledge points of knowledge and thinking carried by members to function, it must be through three stages of knowledge absorption ability. Point elements are integrated, and the focus of each process/phase integration is different. The three stages of knowledge absorption (knowledge exploration, knowledge transformation and knowledge utilization) solve the knowledge dilemma and form a shared think tank. We assume that the various influencing factors in the process of the knowledge point entering from the think tank space to the explored think tank are defined as effective exploration. The various influencing factors in the process of the knowledge point from the explored think tank to the transformed think tank are defined as effective transformation. The various influencing factors in the process of transforming think tanks into the use of think tanks are defined as effective use.

Assume that the tutor team size is relatively stable for a certain period of time. In order to maintain the stability of the team's knowledge, it is assumed that the total number of knowledge points of the team is always N, N is not equal to 0 and is sufficiently large, and the new knowledge and knowledge generated in the team is depreciated. The join rate α of the new knowledge point is equal to the knowledge point exit rate β. The knowledge points of the team at time t are divided into three categories: A is a knowledge exploration type, which means that the relevant knowledge points have been probed and collected, and after the knowledge points are effectively contacted and explored, it is possible to convert to the next stage. Knowledge points that cannot be converted are taken out of standby. Class B knowledge transformation type can be effectively linked with other knowledge points and has the potential to become available knowledge. Class C is the knowledge utilization type. On the basis of effective contact exploration and related transformation, knowledge is effectively transformed and absorbed by each other's knowledge points, and then becomes available knowledge. All of them have used knowledge to form a team's shared think tank, which ultimately solves the knowledge dilemma.

Based on the idea of stock flow in system dynamics, assuming that a small number of tiny knowledge points constitute the target knowledge, we use knowledge points as the basic analysis unit, so that $A_{(t)}$,$B_{(t)}$ and $C_{(t)}$ represents the proportion of A, B, and C knowledge points at total knowledge points at time t. Because there are enough knowledge points, we can assume $A_{(t)}$,$B_{(t)}$ and $C_{(t)}$ as continuous differentiable variables. It is assumed that the transformation and utilization of knowledge is started by the mutual collision of knowledge points, and the probability of each knowledge point exploring each other is equal. Under the influence of various cognitive, environmental and behavioral factors within the team, the effective exploration rate of new knowledge points and original knowledge points inflow per unit time is constant λ, then the conversion rate of new knowledge and original knowledge in the process of knowledge transformation $A\mu$, so $\delta=\lambda\mu$ per unit time represents the knowledge utilization of the original knowledge of the new knowledge. The probability of knowledge aging exit is represented by $C\beta$, and β_1, β_2 and β_3 respectively indicate the exit rate of knowledge points in the stage of effective exploration, effective transformation and effective utilization. Since the knowledge points with active forms are the knowledge points that facilitate the organization of innovative behaviors, the knowledge points that are intentionally hidden are not considered. The tutor team members integrate the knowledge points through knowledge absorption (including knowledge exploration, knowledge transformation, and knowledge utilization), and the focus of each process/phase integration is different.

4. Analysis of main parameters affecting the cultivation of knowledge innovation

4.1 Establish a diversified channel for member communication and enhance the opportunities for effective knowledge exploration

In order to gradually transfer knowledge from the think tank space to the shared think tank, first of all, the exploratory type of knowledge is transformed into the transformed type of knowledge, and the proportion of the type A knowledge in the total knowledge is reduced. Since the addition rate α of the new knowledge point does not change for a certain period of time, if $A_{(t)}$ is decreased, $\lambda\mu B$ is increased or β_1 is increased or they are simultaneously increased. On the one hand, $\lambda\mu B$ and β_1 cannot increase at the same time. On the other hand, since β_1 is the knowledge exit rate in the effective exploration stage, the increased exit knowledge point will reduce the proportion of effective conversion, which is not conducive to the growth of organizational knowledge, so the team Construction should focus on introducing process management to increase $\lambda\mu B$. λ is the effective exploration rate, μ is the effective conversion rate of knowledge. The more knowledge comes from effective exploration, the more knowledge can be transformed. Therefore, establishing diversified channels of communication between members can enhance the effective contact and further exploration of knowledge. Communication opportunities allow members and teams to form a unified value orientation, avoiding member withdrawal and knowledge loss. The specific approach can be a combination of institutionalized communication and non-institutional communication. Institutionalized communication focuses on the tutors and students who regularly gather together with project needs (project seminars, working groups, etc.), communicate purposefully, and improve the overall organization by communicating with each other's work goals and task progress. Knowledge exploration rate, stimulating thinking collision and knowledge intersection; non-institutional communication mode is to contact with informal communication channels other than hobbies, personality temperament characteristics, living environment, etc., so as to gain mutual trust and affection, expand knowledge contact and Thinking fusion opportunities.

4.2 Strengthen incentives and policy support to stimulate the vitality of knowledge transformation

When the transformed knowledge is transformed into the utilization knowledge, the proportion of the B knowledge in the total knowledge is reduced, that means $\lambda\mu A < \mu\delta C + \beta_2$ should be satisfied. According to the knowledge integration process, $\mu\delta C$ and β_2 cannot be simultaneously increased, so $\mu\delta C$ is required to increase bigger. At this time, the key discussion on how to maximize the knowledge conversion rate μ is an important issue. Knowledge transformation is mainly affected by the difficulty of knowledge, cooperation costs, incentives and policy support factors (work compensation, equity incentives, welfare incentives, etc.). The research and development of science and technology has typical characteristics of uncertainty and complexity. It is usually a long time and effort for innovative team members to solve a certain technical problem, and the probability of successful resolution is often low. In this case, not only members need to be researched. Individuals have extensive knowledge and generous basic knowledge, and are willing to spend time learning different subjects' knowledge, techniques, and methods. Major knowledge innovations are often generated in the interdisciplinary research process. If students are still willing to work hard for the team's goals after weighing the cooperation costs, they need teachers to stimulate the innovation thinking collision by establishing incentive and policy support systems. Actively participate in knowledge transfer activities.

4.3 Enhance member trust relationships and catalyze the effective use of knowledge

Class C knowledge is the utilized knowledge, and the more knowledge is effectively utilized, that we will benefit more. All of the shared think tanks that have used the knowledge to form a team can ultimately solve the knowledge dilemma. β_3 represents the knowledge exit rate for the effective utilization phase. If $\mu\delta B > \beta_3$ is to be used, the first method is to minimize the exit rate of the knowledge utilization stage. The second method is to increase the knowledge in effective contact exploration and association transformation. On the basis of this, the members' knowledge points are effectively transformed and absorbed, and then become available knowledge. We believe that a good trust relationship can not only reduce the use of stage knowledge exit rate, but also increase knowledge exploration rate and knowledge utilization. Knowledge points derived from different members' thinking or subject knowledge are transformed into different sizes of knowledge through cross-fusion. Whether or not these newly generated knowledge can be truly utilized is the key to solving complex knowledge dilemmas, and the trust relationship plays a decisive role. A good relationship of trust promotes the use of knowledge and, on the contrary, hinders the use of knowledge. The higher the level of trust of knowledge-based members, the easier it is to absorb and reuse knowledge. Insufficient trust or fear of losing competitive advantage often affects knowledge flow sharing, and the formation of individual knowledge monopoly leads to peer-closed research behavior, resulting in knowledge faults or repetitive labor results.

5. Team development recommendations

The knowledge innovation training of the new engineering tutor system should focus on process management. On the one hand, to improve the efficiency of team research and development, it is necessary to create a research and development atmosphere that is tolerant and allows for trial and error. The atmosphere of tolerance and harmony will make members feel that they are accepted by the team, which will enhance the self-evaluation of members' results and behaviors and improve individual results. Expectation and self-efficacy, in turn, encourage members to fully communicate to ensure the completion of the team's mission and goals, and enhance the trust of team members; on the other hand, the establishment of regular informal communication channels is more conducive to effective communication of team members, which requires Funding and policy support, relying on communication platforms and physical exchange sites to establish a regular communication mechanism, naturally expand the opportunities for members to exchange, and increase the possibility of generating new knowledge and new ideas in social networks, with a view to further promoting the transformation of knowledge into productivity and promoting society. The economy is fully developed.

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References

[1] Ye Min, Kong Han, Bing Zhang. New Engineering: From Idea to Action. Higher Engineering Education Research, Vol. 1 (2018) No.28, p. 24-31.

[2] Wang Bin, Gao Jiangbo, Chen. Thoughts on Talent Cultivation for "New Engineering" University. Educational Exploration, Vol. 1 (2018) No.15, p. 52-55.

[3] Zhong Denghua. The Connotation and Action of New Engineering Construction. Higher Education Research, Vol. 3 (2017) No.33, p. 1-6.

[4] Kamp, A. Engineering Education in the Rapidly Changing World: Rethinking the Vision for Higher engineering Education (2nd revised edition ed.) Delft: TU Delft, Faculty of Aerospace

Engineering. Vol. 5 (2016) No.32, p. 14-17.

[5] Katri Huutoniemia, Julie Thompson Kleinb, et al. Analyzing interdisciplinarity: Typology and indicators. Research Policy, Research Policy Vol. 3 (2010) No.39, p. 79-88.

[6] Wolff, K., Luckett, K. Integrating multidisciplinary engineering knowledge. Teaching in Higher Education, Vol. 1 (2013) No.18, p. 78-92.

[7] Feng Jiqin. Research and Exploration of Graduate Education Based on Team Tutor System. China Electric Power Education, Vol. 2 (2014) No.25, p. 4-10.

[8] Li Zengsen. Examination and Optimization of the Problem of Graduate Tutor System. Shanghai Education Evaluation Research, Vol. 4 (2018) No.27, p. 15-19.

[9] Zhao Yanli, Kan Ganggang, Zhang Li. Influence of the construction of inter-disciplinary tutor team on the innovation ability of graduate students. Heilongjiang Education (High Education Research and Evaluation), Vol. 9 (2016) No.40, p. 63-64.

[10] Wang Xiaohong, Jin Ziqi, Jiang Hua. System Dynamics Research on Knowledge Innovation of Innovative Team Members. Research and Development Management, Vol. 2 (2014) No.26, p. 120-128.

[11] BANDURA, A. Social Learning Theory. Englewood Cliffs, N. J. Prentic-Hall, Vol.13 (1977) No.14, p. 138-145.

[12] Bernard L Simonin. An empirical investigation of the process of knowledge transfer in international strategic alliances. Journal of International Business Studies, Vol. 1 (2004) No.35, p. 407-427.