OPEN ACCESS

EURASIA Journal of Mathematics Science and Technology Education
ISSN: 1305-8223 (online) 1305-8215 (print)
2017 13(8):5327-5341
DOI: 10.12973/eurasia.2017.00985a

Influence Mechanism of External Social Capital of University Teachers on Evolution of Generative Digital Learning Resources of Educational Technology of University Teachers

-Empirical Analysis of Differential Evolution Algorithm and Structural Equation Model of Bootstrap Self-extraction Technique

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Received 3 April 2017 ▪ Revised 10 June 2017 ▪ Accepted 3 August 2017

ABSTRACT

Conceptual framework of influence mechanism of external social capital of university teachers on evolution of generative digital learning resources of educational technology of university teachers is constructed in this paper, which elaborates transmission mediation role of knowledge search and knowledge activity of education technology of university teachers, as well as positive moderating effect of interactive memory system and organizational citizenship behavior of university teachers. The professional teachers in 211 universities and 985 universities in eastern and central regions of China are taken as the subjects of questionnaire, and empirical analysis of influence mechanism is carried out by differential evolution algorithm and structural equation model based on Bootstrap self-extraction technique. Empirical analysis results show that external social capital of university teachers has a significantly positive effect on knowledge search and knowledge activity of education technology of university teachers. Knowledge search and knowledge activity of education technology significantly and positively promote evolution of generative digital learning resources of educational technology of university teachers. Interactive memory system and organizational citizenship behavior of university teachers significantly and positively moderate relationships among knowledge search, knowledge activity of education technology of university teachers and evolution of generative digital learning resources.

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State of the literature

- Domestic and foreign scholars have made useful explorations on the contents of external social capital, knowledge activity, knowledge search, and evolution of generative digital learning resources in educational technology, and have achieved some results. Scholars take connotation, construction dimensions, evaluation indicators system, current status, existing problems, positive influence effects and function results with the help of qualitative methods of evolution of generative digital learning resources into account (Yu, Yang, & Cheng, 2009; Zhang & Wang, 2012; Yang & Yu, 2011; Yang, Cheng, & Yu, 2013; Yang & Yu, 2013; Li & Tu, 2007; Yang & Yu, 2013; Yang, 2015). Scholars focus on connotation, construction dimensions, evaluation indicators system, positive influence effects and function results, influence factors, relationships among other key variables of external social capital, knowledge search (Nahapiet & Ghoshal, 1998; Krause, Handfield, & Tyler, 2007; Zhang, 2010; Peng &Li, 2011; Peng, 2010; Laursen & Salter, 2006; Chen, Yu, & Fan, 2010; Adler & Seok, 2000; Xie, Chen, &Cheng, 2011; Xie, Zhao, &Cheng, 2011; Allen, 2000; Uzzi, 1997; Uzzi, 1996). Scholars focus on connotation, construction dimensions, evaluation indicators system, positive influence effects and function results, influence factors, relationships among other key variables of knowledge activity (Yang, 2003; Yang & Zheng, 2009; Yu, 2011; Li & Si, 2009; Shi, Sun, &Liu, 2013). However, the papers which can use quantitative research methods to extend variables of external social capital, knowledge search and activity to the field of educational technology are relatively lack. The literatures of influence factors and predecessor variables of evolution of generative digital learning resources are relatively lack. In the scope of education theory and education technology field, the literatures of setting external social capital, knowledge search and knowledge activity of education technology as influence factors and predecessor variables of evolution of generative digital learning resources in educational technology systematically and uniformly are relatively fewer. Furthermore, using quantitative methods, integrating organizational citizenship behavior and interactive memory system, fusing variables of external social capital, knowledge search and activity of education technology, evolution of generative digital learning resources into the same theoretical framework of revealing influence function of mutual function relationships among influence factors on evolution of generative digital learning resources are also relatively lack. University teachers are seldom taken as questionnaire sample, and external social capital, interactive memory system, organizational citizenship behavior, knowledge search, knowledge activity of education technology and evolution of generative digital learning resources are seldom combined together in the same conceptual framework.

Contribution of this paper to the literature

- In view of the above reasons and research status of related literatures, compared with previous literatures, this paper refers to relevant literature achievements, takes knowledge search and knowledge activity of education technology as transmission medium variable, interactive memory system and organizational citizenship behavior of university teachers as moderating variables, uses empirical methods of differential evolution algorithm and structural equation model of Bootstrap self-extraction technique to reveal causal relationships among variables of conceptual model of influence mechanism and expound influence mechanism of external social capital of university teachers on evolution of generative digital learning resources of educational technology of university teachers. In summary, as for contribution and innovation points, the innovations points and contribution of this paper lie in that it puts emphasis on main contents and problems of science and technology education in educational technology scope using the sample and objections of university teachers in educational technology field, furthermore, conceptual model, theoretical hypotheses and empirical conclusion will provide basis for identifying influence factors, mutual function mechanism and causal relationships in enhancing evolution of generative digital learning resources of educational technology of university teachers in educational technology aspects and science and technology education field.

Keywords: evolution of generative digital learning resources of educational technology of university teachers, organizational citizenship behavior of university teachers, interactive memory system of university teachers, knowledge search and knowledge activity of educational technology of university teachers

INTRODUCTION

In recent years, the concept of digital teaching and the concept of productive teaching have been popularized in the teaching process of university teachers. With the development and application of generative digital learning resources in educational technology field, the promotion of the evolution of generative digital learning resources of educational technology of university teachers (Hereinafter referred to as evolution of generative digital learning resources in this paper) became an important way for university teachers to enhance the performance of teaching (Yu, Yang, & Cheng, 2009; Zhang & Wang, 2012; Yang & Yu, 2011; Yang, Cheng, & Yu, 2013; Yang & Yu, 2013; Li & Tu, 2007). Therefore, some papers explore the pre-dependent variables that affect the evolution of generative digital learning resources and the influencing factors of the evolution of generative digital learning resources of educational technology, try to find how to promote the evolution of generative digital learning resources of educational technology, and in which way external social capitals of university teachers promote evolution of generative digital learning resources of educational technology effectively. The above mentioned has aroused concern in academic and business fields, and become one of the focuses in theoretical and industrial research. The theory and practice of educational technology show that external social capital, knowledge search and knowledge activity of educational technology of university teachers, and excellent characteristics of organizational citizenship behavior and interactive memory system of university teachers become key causes and influencing factors that affect evolution of generative digital learning resources in educational technology. In view of these reasons, this paper takes knowledge search and the knowledge activity of education technology as transmission medium variable, interactive memory system and organizational citizenship behavior of university teachers as moderating variables to construct conceptual framework of influencing mechanism of external social capital of university teachers on evolution of generative digital learning resources. Differential evolution algorithm and structural equation model based on Bootstrap self-extraction technique are integrated to verify influence mechanism and conduction path, which provides theoretical framework guidance and practical enlightenment for evolution of generative digital learning resources.

CONCEPTUAL FRAMEWORK of INFLUENCING MECHANISM and THEORETICAL HYPOTHESES

Theoretical Hypotheses

In order to enter into research theme, research background and research scenarios, based on relevant literatures, this paper follows dominant logic and operational thought of relationships between Nomo network and regulation, and combines professional characteristics of university teachers, results of expert interviews, actual questionnaire survey of university teachers and results of spot interviews. This paper selects organizational citizenship behavior and interactive memory system of university teachers as moderating variables, and sets knowledge search and knowledge activity of education technology as transmitting variables. According to causal relationships among variables, this paper proposes theoretical hypotheses, and constructs conceptual framework of influencing mechanism of external social capital of university teachers on evolution of generative digital learning resources based on theoretical hypotheses.

External social capital of university teachers and knowledge search of education technology of university teachers

Social capital is sum of actual or potential resources from or embedded in a network of relationships owned by individuals or social groups (Nahapiet & Ghoshal, 1998; Krause, Handfield, & Tyler, 2007; Zhang, 2010). Typically, social capital is divided into internal social capital and external social capital. External social capital is also known as bridge-type social capital, which is sum of actual resources and potential resources embedded in the external relations network (Nahapiet & Ghoshal, 1998; Krause, Handfield, & Tyler, 2007; Zhang, 2010). External social capital focuses mainly on getting resources from external networks across organizational boundaries. Peng (2010), Peng and Li (2011) divided external social capital into four parts: The first indicator, the intensity of internal and external interaction, is to reflect interaction frequency among internal and external members within certain

period of time. The second indicator, external network density, is to reflect extensive communication degree among internal members of organization and external members. The third indicator, the degree of internal and external trust, is to reflect degree of trust among internal and external members of organization. The fourth indicator, internal and external common language, is to reflect degree of interconnection based on professional knowledge and skills among internal and external members of organization (Peng, 2010; Peng & Li, 2011).

Through the following ways, four dimensions of external social capital of university teachers promote knowledge search of university teachers. Firstly, knowledge search has breadth and depth (Laursen & Salter, 2006; Chen, Yu, & fan, 2010). Knowledge search depth emphasizes the use of the depth of knowledge of the existing stock on the basis of knowing the existing knowledge, and the breadth of knowledge search emphasizes the breadth of developing and using the new knowledge. High frequency contact and close interaction between university teachers facilitate them to establish trust relationship, exchange and integrate educational technical knowledge resources between each other, improve the absorption and recognition of educational technical knowledge and enhance the depth and breadth of educational knowledge search (Adler & Seok, 2000). Secondly, the external network density and the internal and external common language of university teachers can promote the behavior consistency of university teachers in the internal network, improve the efficiency of educational technology and knowledge transfer between university teachers, and facilitate the communication and exchange of information and knowledge between each other. Furthermore, they can promote the trust and relationship commitment between teachers, implement the cooperation depth of educational technical knowledge of university teachers (Xie, Chen, & Cheng, 2011), and strengthen the interaction and learning in educational technology information, knowledge and resources between university teachers. And the open learning mechanism can help university teachers acquire and accumulate educational technology and knowledge (Xie, Zhao, & Cheng, 2011), which will enhance the depth and breadth of knowledge search of educational technology. Thirdly, the higher the density of the external network, the more conducive to enhance the transferring will of the sender of educational technical knowledge, thus promote the transfer efficiency of educational technical knowledge(Zhu, Xu, & Wu, 2011), and facilitate university teachers to have abundant access to network learning resources. At last, the acquired stock, the acquired heterogeneous and the acquired diverse of educational technology information will be enlarged, and the knowledge search breadth of educational technology will be improved, too (Allen, 2000). Fourthly, the degree of internal and external trust and internal and external common language facilitate university teachers to obtain the deeply complicated educational technology and knowledge, explore new solutions to technical information processing and practical problems, and get and integrate educational technical knowledge and experience at different levels and different values. Moreover, they will create and reorganize new educational technology elements and educational technology learning resource, amplify the effects from existing resources of educational technical knowledge, thereby enhancing the depth and breadth of knowledge search of educational technology and obtaining the required technology and knowledge (Uzzi, 1997; Uzzi, 1996). In summary, the following theoretical hypotheses are proposed:

Hypothesis 1: External social capital of university teachers (ESC) has a significantly positive effect on knowledge search of educational technology of university teachers (KS).

Hypothesis 1.1: Internal and external interaction intensity of university teachers (IES) has a significantly positive effect on KS.

Hypothesis 1.2: External network density of university teachers (END) has a significantly positive effect on KS.

Hypothesis 1.3: Degree of internal and external trust of the university teachers (IET) has a significantly positive effect on KS.

Hypothesis 1.4: Internal and external common language of university teachers (IEC) has a significantly positive effect on KS.

External social capital of university teachers and knowledge activity of educational technology of university teachers

Yang (2003), Yang, Zheng, and Chris (2009) divided knowledge into three categories: explicit knowledge, implicit knowledge and active knowledge, and the active knowledge is different from the explicit knowledge and implicit knowledge, which is mainly involved in emotion, personal culture and value orientation. Based on concept of value and shared vision, the active knowledge effectively guides interactions between explicit knowledge and implicit knowledge through ideal, management philosophy, emotional motivation, mission and other forms, which is conducive to organizational learning and strategic decision-making (Yang, 2003; Yang, Zheng, & Chris, 2009). Yu (2011) made a systematic description about active knowledge as follows: on the basis of values, ambitions, ideals and vision, people use emotion, motivation, learning needs, attitudes, ethics, moral standards and other forms of expression to make expectation or emotional experiences from objective things, so as to understand the importance of objective matters. The active knowledge of education technology is seed for university teachers to share belief and play personal role, and the higher activity level of knowledge, the more conducive to university teachers' emotional commitment and motivation, which will promote the sharing of educational technical knowledge between university teachers (Yu, 2011). Internal and external interaction intensity, external network density, internal and external trust and internal and external common language provide an opportunity for university teachers to make internal and external communication, interaction and communication, which facilitates to introduce new external knowledge sources of educational technology and attract new educational technology professionals, and set up new team with differentiation and complementary of education technical knowledge. If university teachers make clear orientation of educational technical knowledge on their own niche, it will optimize the allocation of knowledge resources of educational technology, draw knowledge map of educational technology, and share belief of activity knowledge of education technology based on trust. Finally, it will form and agree with each other's values, ambition and ideal vision, promote emotional commitment and motivation among university teachers, and improve level of knowledge activity of education technology. To sum up, the following hypotheses are made:

Hypothesis 2: External social capital of university teachers significantly enhances knowledge activity of educational technology of university teachers (KA).

Hypothesis 2.1: IES significantly enhances KA.

Hypothesis 2.2: END significantly enhances KA.

Hypothesis 2.3: IET significantly enhances KA.

Hypothesis 2.4: IEC significantly enhances KA.

Knowledge search of education technology, knowledge activity of education technology and evolution of generative digital learning resources of educational technology of university teachers

Learning resource is the core element of the ubiquitous learning ecosystem. The ubiquitous learning requires a large amount of generative learning resource with sustainable development and open structure (Yu, Yang, & Cheng, 2009; Zhang & Wang, 2012; Yang & Yu, 2011; Yang, Cheng, & Yu, 2013; Yang & Yu, 2013; Li & Tu, 2007). According to the different generation ways of learning resources, learning resources can be divided into pre-generated resource and generative resource, and generative resource has a better expansibility, adaptability and evolvability, which can be adjusted according to the needs of teachers and students dynamically. But it is disadvantageous to take a long time to generate, moreover, the generation process is difficult to control, and the quality of resources varies greatly. The typical generation resources include Wikipedia, learning cell, generative network curriculum (Yu, Yang, & Cheng 2009; Zhang & Wang, 2012; Yang & Yu, 2011; Yang, Cheng, & Yu, 2013; Yang & Yu, 2013; Li & Tu, 2007; Yang & Yu, 2013). The evolution of generative digital learning resources of educational technology refers to the improvement and adjustment of the content and structure of the learners to

meet the dynamic and personalized learning needs of the learners in a digital learning environment, and adapt to the changing learning environment continuously (Yu, Yang, & Cheng, 2009; Zhang & Wang, 2012; Yang & Yu, 2011; Yang, Cheng, & Yu, 2013; Yang & Yu, 2013; Li & Tu, 2007; Yang & Yu,2013). Evolution of generative digital learning resources of educational technology of university teachers includes five construction dimensions of learning resource contention, learning resource configuration, marking standards, learning resources teaching quality and attribute, learning resource activity (Yang & Yu, 2013).

Knowledge search of education technology of university teachers is mainly through the following channels to facilitate the evolution of generative digital learning resources. Firstly, to enhance the depth and breadth of the knowledge search of education technology of university teachers is advantageous to explore and create new explicit knowledge and implicit knowledge of educational technology (Li & Si, 2009), stimulate creative idea of educational technology, and enhance the knowledge understanding depth of educational technology(Adler &Seok,2000). The above enhancing is also conducive to the transformation of implicit knowledge into implicit knowledge, explicit knowledge into explicit knowledge, implicit knowledge into explicit knowledge and the explicit knowledge into implicit knowledge. Furthermore, it can promote the spiral of educational technical knowledge, and integrate the spiraling educational technical knowledge into teaching resources of educational technology to promote the generative digital learning resources evolution. Secondly, the effective breadth and depth of knowledge search of education technology is easy for university teachers to implement the separation between the persons and educational technical knowledge by encoding strategy, spread educational technical knowledge, use the knowledge base to store educational technical knowledge, and promote the improvement and the repeated application of educational technical knowledge (Li & Si, 2009). In addition, the effective breadth and depth of knowledge search of education technology will help realize mutual transformation between explicit knowledge and implicit knowledge to form a knowledge spiral of educational technology, explore new methods to process education technical information and solve practical problems of educational technology, and expand the acquired storage of educational technology information. And it can obtain heterogeneous information of educational technology on the bases of keeping homogeneous information of educational technology, create new educational technology elements and reorganize resources, and amplify the effect generated by the knowledge resource of education technology and obtain the required knowledge of educational technology. Finally, it will provide the new explicit and implicit knowledge source for the evolution of generative digital learning resources of educational technology of university teachers, and promote the evolution of generative digital learning resources (Uzzi, 1997; Shi, Sun, & Liu, 2013).

Knowledge activity of education technology of university teachers is mainly through the following channels to facilitate the evolution of generative digital learning resources of educational technology of university teachers. Firstly, the higher knowledge activity degree of educational technology of university teachers will be more conducive to the emotional commitment, emotional motivation and knowledge sharing of professional university teachers (Yu, 2011). If the education technical knowledge obtained by sharing is integrated into generative digital learning resource of educational technology of university teachers, it will promote the evolution of generative digital learning resource of educational technology. Secondly, the higher the knowledge activity degree of educational technology of university teachers, the more conducive to the establishment of the relationship of trust and emotional commitment among university teachers, which will form an interactive communication atmosphere, promote university teachers to carry out joint planning activities for educational technical knowledge, and build the interoperability and compatibility of educational technical knowledge and skills. Meanwhile, it can strengthen the standardization and consistency of educational technical information and knowledge process, stimulate the conversion between explicit knowledge and implicit knowledge, and apply the standardization and consistency of educational technology information and knowledge process to the generative digital learning resources. And all of these will help the evolution of generative digital learning resources (Shi, Sun, & Liu, 2013). In conclusion, the following theoretical hypotheses are proposed:

Hypothesis 3.1: KS significantly promotes the evolution of generative digital learning resources (GDLRE).

Hypothesis 3.2: KA significantly promotes GDLRE.

The positive moderating effect of interactive memory system of university teachers

An interactive memory system is a cooperative division system which is formed by internal team members who rely on each other to encode, store, and extract knowledge in different areas (Hollingshead, 2001; Wang & Xue, 2011; Lewis, 2003; Lewis, 2004).Interactive memory system mainly includes three dimensions: specialization, reliability and coordination(Hollingshead,2001; Wang & Xue,2011; Lewis,2003; Lewis, 2004). The more complicated the educational technical knowledge of university teachers, the more teachers in different fields need to be integrated to decode and encode. The establishment of interactive memory system can bring teachers in different fields together to cooperate with each other in a reliable way, so as to improve the absorptive ability and searching ability of receivers of educational technical knowledge. Related research results show that the interactive memory system can promote communication and cooperation among university teachers, improve the acquisition, sharing, integration and application of knowledge search of educational technology, and enhance the depth and breadth of knowledge search of educational technology. Interactive memory system promotes university teachers to cooperate and communicate, generate the cognition of distribution of internal educational technical knowledge, and understand the position of professional knowledge of educational technology. This system can eliminate barriers to the transfer of educational technical knowledge, reduce the viscosity of educational technical knowledge, and facilitate the search and integration of external and internal educational technical knowledge. Finally, it can promote the evolution of generative digital learning resources.

Interactive memory system is convenient for university teachers to make a cooperative division of educational technical knowledge, set up a good organization atmosphere, and promote the sharing of educational technical knowledge. Burke and others study the positive promoting effect of organizational atmosphere on informal knowledge sharing behavior (Burke & Weir, 1978). The interactive memory system formed in the university can absorb more external talents, expand knowledge sources of educational technology of university teachers, and provide opportunities for internal and external cooperation that will improve the interactive memory system. It is necessary to establish a differentiated and complementary experts' team, draw a map of educational technical knowledge based on "goals-expertise-members", find a clear ecological position for their own educational technical knowledge, and optimize the allocation of knowledge resources of educational technology and transfer educational technical knowledge with trust. In addition, the interactive memory system can reduce knowledge senders' concerns and the risk to transfer educational technical knowledge, decrease the protection awareness of educational technical knowledge, and enhance the cooperation willingness and trust between knowledge senders and receivers. Active and specialized modules and coordinated operations can shorten the cultural distance, spatial physical distance and knowledge distance between knowledge senders and receivers, and create some good communication channels and organizational environment. Learning and planning a management strategy for educational technical knowledge can improve teachers' interactive study and the incentive system of educational technical knowledge, which will coordinate the action and activity rhythm between each other, and make them to recognize and show respect to mutual culture, values, behavior patterns and action criterion. All of the above mentioned will strengthen interactive media, optimize the network structure of educational technical knowledge, and make university teachers know the distribution of educational technical knowledge between themselves, which will arouse teachers' knowledge activity of educational technology, and promote the evolution of generative digital learning resource. The following hypotheses are derived from the above:

Hypothesis 4.1: Interactive memory system (IMS) significantly and positively moderates relationships between KS and GDLRE.

Hypothesis 4.2: IMS significantly and positively moderates relationships between KA and GDLRE.

The positive moderating role of organizational citizenship behavior of university teachers

Organizational citizenship behavior is required by the organization, although it is not included in the formal job requirements. Regardless of the formal requirements, organizational citizenship behavior is a kind of outside action that is beneficial to the organization, and it is a spontaneous behavior of organization members that cannot get a formal organizational return, but it has a promoting effect on organizational performance (Bateman &

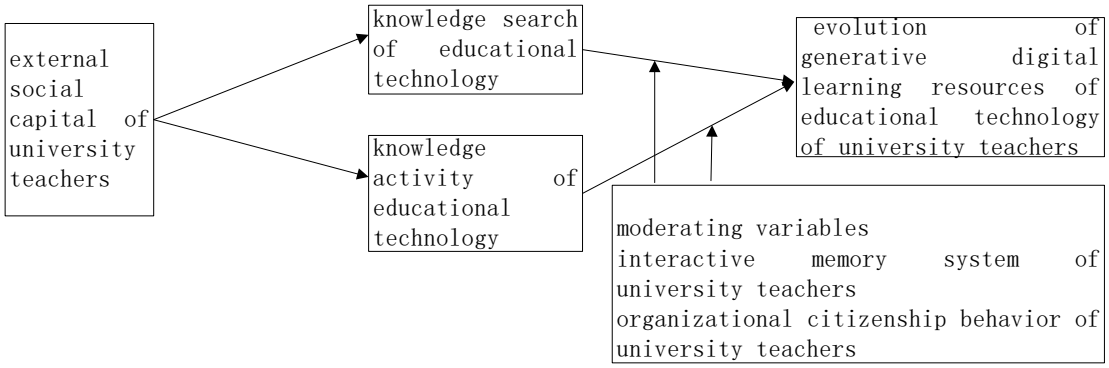

Figure 1. Conceptual framework of influence mechanism

Organ, 1983; Organ, 1990). Organizational citizenship behavior consists of two construct dimensions, namely, generalized compliance and altruism (Smith, Organ, & Near, 1983). In view of the characteristics of university teachers' occupation and the relevant research results of scholars, the indicators of organizational citizenship behavior of university teachers include four dimensions: initiative, altruism, self-development and interpersonal harmony (Bateman & Organ, 1983; Organ, 1990; Smith, Organ, & Near, 1983; Liao, Li, & He, 2016). Organizational citizenship behavior of university teachers can promote university teachers to engage in the teaching work, making them willing to take on extra responsibilities and teaching tasks, help other teachers or organization to complete the task and solve the problem. And this behavior can remove the adverse impact generated from the pursuit of personal interests, thus achieving the harmonious interpersonal relationship, and improving self-development and teaching performance of university teachers (Liao, Li, & He,2016).The occupation characteristics of university teachers need the initiative and dedication of university teachers, and it is easy to create a sense of organizational identity and belonging among university teachers, which pushes university teachers to practice the organizational citizenship behavior actively, feedback the school and society, and promote teachers' behavior internalization and identity (Liao, Li, & He, 2016). The occupation characteristics succeeded in arousing university teachers' improvement of work performance, active acquirement of learning resources of educational technology and active search of educational technology knowledge, and enhancement of knowledge activity and the breadth and depth of knowledge search of educational technology. If the searched and active knowledge of education technology is integrated into generative digital learning resource of educational technology, it will promote the evolution of generative digital learning resources. In conclusion, the theoretical hypotheses are put forward:

Hypothesis 5.1: Organizational citizenship behavior of university teachers (OCB) significantly moderates positive relationships between KS and GDLRE.

Hypothesis 5.2: OCB significantly moderates positive relationships between KA and GDLRE.

Construction of Conceptual Framework of Influence Mechanism

According to the theoretical hypotheses, the conceptual framework of influence mechanism of external social capital of university teachers on the evolution of generative digital learning resources is constructed as **Figure 1**, in which knowledge search and knowledge activity are regarded as transmission mediating variables, and interactive memory system and organizational citizenship behavior as moderating variables.

RESEARCH DESIGN AND EMPIRICAL ANALYSIS OF INFLUENCING MECHANISM

Scale Design

Referring to the relevant domestic and foreign literature and mature scales, this paper selects some evaluating indicators and designs Likert 1-7 points scale. The related references of the scale are shown in **Table 1.**

Table 1. Scale design and references

Variables	Related References
ESC KS	(Nahapiet & Ghoshal, 1998; Krause, Handfield, & Tyler, 2007; Zhang, 2010; Peng &Li, 2011; Peng, 2010; Laursen & Salter, 2006; Chen, Yu, & Fan, 2010; Adler & Seok, 2000)
IMS	(Hollingshead, 2001; Wang & Xue, 2011; Lewis, 2003; Lewis, 2004)
KA	(Yang, 2003; Yang & Zheng, 2009; Yu, 2011)
OCB	(Burke & Weir, 1978; Bateman & Organ, 1983; Organ, 1990; Liao, Li, & He, 2016)
GDLRE	(Yu, Yang, &Cheng, 2009; Zhang & Wang, 2012; Yang & Yu, 2011; Yang, Cheng, & Yu, 2013; Yang & Yu, 2013; Li & Tu, 2007; Yang & Yu, 2013; Yang, 2015)

Data Acquisition

Referring to the related research achievements (Yu, Yang, & Cheng, 2009; Zhang & Wang, 2012; Yang & Yu, 2011; Yang, Cheng, & Yu, 2013; Yang & Yu, 2013; Li & Tu, 2007; Yang & Yu,2013; Yang, 2015), the learning cell system is a new opening knowledge community, including six core modules such as learning cell, knowledge group, knowledge cloud, learning community, learning tools and individual space. Learning cell is the basic resource unit of learning system, and it is a typically generative digital learning resource, which can aggregate and generate multiple knowledge groups. In this paper, a number of learning cells belonging to educational technology subject are selected from the learning cell system, and the research objects are focused on the registered professional teachers of the universities in several learning cells. In the paper, the design of Likert 5 points scale and questionnaire method are used, and the methods of convenience sampling, subjective sampling, stratified sampling and random sampling are combined. By means of on-site interviews, questionnaires, and E-mail, the professional teachers in 211 universities and 985 universities in central and eastern part of China were asked to answer the questions according to their actual situation, and all of the teachers need to master related knowledge of generative digital learning resources of educational technology, and the related technology of learning cell and learning system. 750 questionnaires were sent, in which 650 questionnaires were actually collected. 150 invalid copies are removed, and 500 questionnaires are valid. The effective rate of the questionnaire is 66.67%. Among the subjects, 50% are female and 50% are male. Survey samples are typical in the region and the scale of university teachers, 211 universities and 985 universities in eastern region account for 70%, 30% in central region. The age and working life of professional teachers in the survey are normally distributed approximately, and average working years are more than 10 years with rich teaching experience. The survey work was conducted by stages. The independent sample t test shows that there is no significant difference between the questionnaires completed early or late, and there is no response bias in the collected questionnaires.

Reliability Test and Validity Test of Scale

Based on software SPSS17.0, the method of exploratory factor analysis is used to test the scale reliability, construct validity and building validity, as the results shown in **Table 2.** Based on software AMOS22.0, the method of confirmatory factor analysis is used to test the assembly validity and convergent validity of the scale, as the result shown in **Table 2.** Cronbach of the total scale is greater than 0.7, and the values of CITC and item deleted Cronbach are both higher than 0.5, which shows that the scale is reliable very much. The validity tests include the tests of convergent validity and construct validity. In order to ensure the content validity and index reliability of scales, the maturity scale at home and abroad is used. **Table 2** shows that the average KMO value is greater than 0.7, sig. value of Bartlett's test is 0.000 less than 0.001, the cumulative extraction square of common factor and the total variance loaded with interpretation are both greater than 50%, and the factor component loadings of each variable are greater than 0.5, all of which show that the scale has a better construct validity to be built. CR values of the scale variables are all higher than 0.6, and the corresponding AVE values are higher than 0.5, showing that the scale has better assembly validity and convergent validity.

Table 2. Test results of reliability and validity of scale

Scale Variables	Cronbach	CITC	Item Deleted Cronbach	KMO	Sig. Value of Bartlett Sphericity Test	Cumulative Extraction Square of Common Factor	Factor Loading	CR Value, AVE Value
ESC	0.913	0.650-0.840	0.885-0.912	0.891	0.000	69.835%	0.747-0.899	0.9325, 0.6983
IMS	0.889	0.604-0.755	0.862-0.885	0.792	0.000	64.517%	0.715-0.841	0.9159, 0.6454
OCB	0.877	0.638-0.717	0.850-0.864	0.848	0.000	62%	0.750-0.814	0.9072, 0.6198
KS	0.795	0.537-0.698	0.695-0.778	0.779	0.000	62.155%	0.731-0.854	0.8723, 0.6309
KA	0.804	0.593-0.661	0.734-0.767	0.783	0.000	63.097%	0.773-0.827	0.8198, 0.5339
GDLRE	0.847	0.507-0.716	0.804-0.845	0.807	0.000	57.227%	0.631-0.825	0.8884, 0.5723

Table 3. Executive parameters (executive software is software matlab and stata, and executive parameters are averaged)

Serial Number	Executive Parameter Name	Executive Parameter Details
1	Tested Functions	17 minima in the whole benchmark functions are used as test functions (unimodal function, basic multimodal function, extended multimodal function, mixed composition function)
2	Test dimension size of benchmark function	30
3	Population size	50
4	Maximum evolution algebra of each function	10000
5	Number of independent operation of each function	25

The Process and Results of Empirical Analysis

(1) Based on the data collected from the questionnaire and the tests of scale reliability and validity, differential evolution algorithm is adopted, and outstanding individual samples are searched from 500 collected professional teachers in the universities. Excellent samples that will move into the next generation of population groups are used as the empirical analysis samples of structural equation model (SEM) based on Bootstrap self - extraction technique. The main purpose of differential evolution algorithm is to search for individual samples with good fault-tolerant and strong learning ability, so that better individuals with strong learning ability will enter into the next generation groups to maximize the overall search function (Li, Guo, Li, & Liu, 2016; Guo, Li, & Li, 2014; Deb, 2000). Based on the collected samples of 500 university professional teachers, this paper uses differential evolution algorithm, and uses software Matlab and software Stata to set executive parameters, as shown in **Table 3**. The target is to tap the causal relationship between variables, the interaction among six variables that affect the theoretical framework of the influence mechanism, and the influencing mechanism of external social capital of university teachers on the evolution of generative digital learning resources of educational technology of university teachers, in which knowledge search and knowledge activity are regarded as transmission variables, and interactive memory system and organizational citizenship behavior as positive moderating variables.

The related principles, modeling steps and processes of differential evolution algorithm are as follows (Li, Guo, Li, & Liu, 2016; Guo, Li, & Li, 2014; Deb, 2000). Differential evolution algorithm includes four basic operations: population initialization, variation, crossover and selection, and the modeling steps and processes are population initialization, variation based on difference, crossover, selection, termination, output, feedback (Li, Guo, Li, & Liu, 2016; Guo, Li, & Li, 2014; Deb, 2000). The main procedures and calculation sections are as follows:

Firstly, encode.

Secondly, construct individual structure. The population size is indicated by NP, and individual i in the population is recorded in generation G as: $\vec{X}_{i,G} = [X_{1,i,G}, X_{2,i,G}, \dots, X_{D,i,G}]$

Among them, D is the dimension contained by the individual.

Again, initialize populations. The formula for initializing population is:

$$X_{j,i,0} = X_{j,min} + rand_{i,j}(0,1) \times (X_{j,max} - X_{j,min})$$

Among them, $X_{j,i,0}$ is the value of dimension j of individual i in the population; when G=generation 0, $rand_{i,j}(0,1) \in [0,1]$ and randomly generated; $X_{j,min} \in X_{min} = \{X_{1,min}, X_{2,min}, \dots, X_{D,min}\}$is the lower bound of dimension j of searching space; $X_{j,max} \in X_{max} = \{X_{1,max}, X_{2,max}, \dots, X_{D,max}\}$ is the upper bound of dimension j of searching space; X_{min} and X_{max} are the vector expression formula of the lower and upper bounds of searching space.

Fourthly, vary the variation. The variation process follows:

$$V_{k,G} = X_{m,G} + F(X_{i,G} - X_{j,G}) \quad (1)$$

In the formula: $X_{k,G}$ is individual K to be varied in the current population; $X_{m,G}, X_{i,G}, X_{j,G}$ is a individual selected at random in the current population, and $k \neq m \neq i \neq j$; $X_{k,G}$ is a varied individual; F ∈ [0, 1] is a scaling factor. DE/x/y/z is usually used to represent different patterns of variation, and DE represents differential evolution algorithm; X is the basic item in front of the difference item; Z is a crossover model.

Fifthly, crossover. Cr ∈ [0,1] shows crossover probability. There are two forms of crossing:

① Index model is:

$$u_{j,i,G} = \begin{cases} v_{j,i,G}, j = \langle n \rangle_D, \langle n+1 \rangle_D, \dots, \langle n+L-1 \rangle_D \\ x_{j,i,G}, j \in [1, D] \end{cases} \quad (2)$$

② Binomial model is:

$$u_{j,i,G} = \begin{cases} v_{j,i,G}, (rand_{i,j}(0,1) \leq C_r or j = j_{rand}) \\ x_{j,i,G}, others \end{cases} \quad (3)$$

Among them, $j_{rand} \in [1, 2, \dots, D]$ is a value chosen at random.

Sixthly, selection. After the crossover, the individual $U_{i,G}$ and the target individual $X_{i,G}$ are sequentially substituted into the objective function for comparison, and the selection process is:

$$X_{i,G+1} = \begin{cases} U_{i,G}, f(U_i, G) \leq f(X_{i,G}) \\ X_{i,G}, others \end{cases} \quad (4)$$

(2) The differential evolution algorithm is adopted to identify the outstanding individual samples and the next generation population from outstanding individuals. And the excellent searched samples and the next generation population are used as the empirical analysis samples of structural equation model (SEM) based on Bootstrap self -extraction technique. The normal distribution is tested by software AMOS22.0. The values of multivariate skewness coefficient and multivariate kurtosis of variables are less than 10, and the critical comparison values CR corresponding to kurtosis and skewness of variables are between -2 and 2, showing that variables are subordinated to the normal distribution. On the basis of the test of variable normal distribution, the original structure equation model based on Bootstrap is established to reflect latent variables and causal relationship between latent variables, and Bootstrap self-extraction technique is used to estimate path coefficient, as the results shown in **Table 4.** The fitting goodness index corresponding to the original structure equation model based on Bootstrap self-extraction technique does not reach the minimum standards of regulation. The rate of chi-square to

Table 4. Original results of structure equation model based on Bootstrap (Bootstrap sample numbers are 2000)

Routes and paths	Path Coefficient	Significance Level	Route and Paths	Path Coefficient	Significance Level
IES→KS	0.362	p<0.01	KS→GDLRE	0.338	p<0.01
IES→KA	0.287	p<0.05	KA→GDLRE	0.327	p<0.01
END→KS	0.351	p<0.01	IMS →GDLRE	0.304	p<0.01
END→KA	0.266	p<0.05	KA * IMS→GDLRE	0.251	p<0.05
IET→KS	0.327	p<0.01	KS * IMS→GDLRE	0.276	p<0.05
IET→KA	0.249	p<0.05	OCB→GDLRE	0.282	p<0.05
IEC→KS	0.224	p>0.05	KS* OCB→GDLRE	0.267	p<0.05
IEC→KA	0.206	p>0.05	KA * OCB→GDLRE	0.243	p<0.05

Table 5. Final results of structure equation model based on Bootstrap (Bootstrap sample numbers are 2000)

Routes and paths	Path Coefficient	Significance Level	Route and Paths	Path Coefficient	Significance Level
IES→KS	0.357	p<0.01	KS→GDLRE	0.314	p<0.01
IES→KA	0.284	p<0.05	KA→GDLRE	0.288	p<0.01
END→KS	0.341	p<0.01	IMS→GDLRE	0.283	p<0.01
END→KA	0.254	p<0.05	KA * IMS→GDLRE	0.239	p<0.05
IET→KS	0.318	p<0.01	KS * IMS→GDLRE	0.252	p<0.05
IET→KA	0.235	p<0.05	OCB→GDLRE	0.261	p<0.05
IEC→KS	0.236	p<0.05	KS * OCB→GDLRE	0.254	p<0.05
IEC→KA	0.228	p<0.05	KA * OCB→GDLRE	0.237	p<0.05

degree of freedom is greater than 1 and less than 3, CFI is greater than 0.9, but RMSEA is higher than 0.08, and TLI is slightly lower than 0.9.

Next is to establish covariation correlations among residuals of observed variables corresponding to the same latent variable, and rebuild a final structural equation model based on Bootstrap self-extraction technology. Bootstrap technology is used to estimate the path coefficient, and the final results are shown in **Table 5.** Finally, the fitting goodness index corresponding to the original structure equation model based on Bootstrap self-extraction technology reaches the minimum standards of regulation. The rate of chi-square to degree of freedom is greater than 1 and less than 3, CFI greater than 0.9, RMSEA lower than 0.08, and TLI is higher than 0.9. Combining the insignificant path coefficient in **Table 4** and final path coefficient results of structure equation model in **Table 5,** it is found that all of the four construct dimensions of ESC: IES, END, IET and IEC have a significant positive role in promoting KS. The path coefficients are 0.357 ($p<0.01$), 0.341 ($p<0.01$), 0.318 ($p<0.01$), and 0.236 ($p<0.05$) respectively, and all of the critical comparison values CR corresponding to the path coefficient are higher than 1.96, indicating that the theoretical hypotheses are verified empirically. The four construct dimensions of ESC are: IES, END, IET and IEC, all of which have a significant positive role in promoting KA. The path coefficients are 0.284 ($p<0.05$), 0.254 ($p< 0.05$), 0.235 ($p<0.05$), and 0.228 ($p<0.05$), and all of the critical comparison values CR corresponding to the path coefficient are higher than 1.96, indicating that the theoretical hypotheses are verified empirically. KS and KA have a significant positive role in promoting GDLRE. The path coefficient are 0.314 ($p<0.01$), and 0.288 ($p<0.01$), and all of the critical comparison values CR corresponding to the path coefficient are higher than 1.96, indicating that the theoretical hypotheses are verified empirically. Corresponding to interaction term of IMS and KS, interaction term of IMS and KA, interaction term of OCB and KS, and interaction term of OCB and KA, the standard path coefficients are 0.252 ($p<0.05$), 0.239 ($p<0.05$), 0.254 ($p<0.05$), and 0.237 ($p<0.05$), and all of the critical comparison values CR corresponding to the path coefficient are higher than 1.96, indicating that the theoretical hypotheses are verified empirically. Both IMS and OCB significantly moderate positive relationships among KS, KA and GDLRE. Namely, IMS and OCB significantly strengthen and deepen positive relationships among KS, KA and GDLRE.

CONCLUSION AND RECOMMENDATION

This paper constructs theoretical framework of influence mechanism of external social capital of university teachers on evolution of generative digital learning resources of educational technology of university teachers, in which it focuses on transmission mediation role of knowledge search and knowledge activity of educational technology, as well as positive moderating effect of interactive memory system and organizational citizenship behavior of university teachers. Data of the questionnaire survey are obtained from professional teachers in 211 and 985 universities in eastern and central regions of China, after scale reliability and scale validity are tested, empirical analysis is carried out by differential evolution algorithm and structural equation model based on Bootstrap self-extraction technique. Empirical analysis results show that external social capital of university teachers has significantly positive effects on knowledge search and knowledge activity of education technology of university teachers. Knowledge search and knowledge activity of education technology significantly and positively promote evolution of generative digital learning resources. Interactive memory system of university teachers significantly and positively moderates relationships among knowledge search, knowledge activity of education technology of university teachers and evolution of generative digital learning resources. Organizational citizenship behavior of university teachers significantly and positively moderates relationships among knowledge search, knowledge activity of education technology and evolution of generative digital learning resources. Practical implications of empirical results are that university teachers should pay attention to both inside and outside bridging effect of external social capital, strengthen internal and external interaction strength of university teacher, external network density and internal and external trust degree, and cultivate internal and external common language of university teachers highly, so as to form a common perception of the same symbols, characters, text and symbol. In addition, university teachers should establish interactive memory system, build professional - reliable- coordinated teams, take initiative to practice organizational citizenship behavior, promote depth and breadth of knowledge search of education technology, enhance knowledge activity of educational technology, and continue to promote evolution of generative digital learning resources of educational technology of university teachers.

ACKNOWLEDGEMENTS

This research is funded by national social science fund project (17CGL020, 17CGL007), national natural science fund project (71403066, 71271063), public research personnel training project of department of science of Liaoning province (2015004005), combination fund of department of science of Liaoning province (201602381), social science plan fund project of Liaoning Province (L15CGL003).

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