Study on the university library sns based on evolutionary game

Liping Fu[1], Yonghui Li[1], Kongguo Zhu[2]*
[1]Public Resource Management Research Center, College of Management and
Economics, Tianjin University, Tianjin, (CHINA)
[2]Library, Shandong Youth University of Political Science, Jinan, Shandong,
(CHINA)
E-mail: zhukongguo@126.com

ABSTRACT

More and more university students is getting used to get information through SNS (Social
Network Service) as the development of network technology, this make university library
SNS play a positive and significant role in university students. In order to better analyze
the status of each participant in SNS, this paper constructed the evolutionary game model
between university library and university students; then analyzed four kinds of results of
system dynamic evolution; further several factors such as the benefit, cost and the status
of the knowledge information management were discussed; finally, some countermeasures
to promote the University Library SNS were put forward.

KEYWORDS

University library; Social network service (SNS); Evolutionary game; Knowledge
information.

INTRODUCTION

With the rapid development of internet, the society is filled with various network information services and applications continually, physical activities of human beings is in online virtualization gradually, and the online access to information and online contact with various social relations has become the important characteristic of time. SNS (Social Network Service) is providing online community for contact and exchange for users based on internet. As a platform of online exchange, university students can get information and knowledge from SNS and involve in various learning activities. In order to provide more convenient service for university students in internet environment, Dong Zhen, Liu Chuanxi, Su Jianhua and Wang Chuyun figured out the libraries of universities would be necessary to change traditional service way to adopt university students' habits of getting information from SNS[1, 2]. To provide better service for university students, the libraries of universities comply with development trend of internet technology and develop the related SNS one after another to improve the study of students and widen their own influence.

At present, SNS in some universities' libraries has become the web site of students for communication and interaction, books and rich reference data recommended by SNS bring conveniences for university students to get information and conduct professional learning, and every kind of activities and timely interaction makes SNS be hot. However, in the practice, user engagement of SNS in many universities' libraries is lacking[3, 4], and some begins to decline caused by management negligence. Since the management of SNS is based on "relationship" between human beings, so the different results show that the participant factors shall be necessary to be discussed. In view of participant factors effect emphasized by evolutionary game in systematic evolution, the following content will try to use evolutionary game to discuss the influence to service from payment of each participant in SNS of libraries.

DUPLICATION DYNAMIC MODEL OF SNS IN UNIVERSITY LIBRARY

Fundamental assumption

Main participants of SNS in university libraries are university library and university students[5], and they have obviously different goals and common interests. The university students take participate in SNS to hope strengthening interaction with classmates and friends of real life by means of online interaction. The main purpose of participating in SNS of university library for them is to get more knowledge and information conveniently and quickly, get resources to fulfill the present and future need, and their degree of recognition, participation degree and interactive activities will influence the development of SNS. SNS established by university library mainly provides the knowledge information relating to library resource to promote the learning communication of university students, and its implementation behavior type or strategy set is ''positive, negative'. The positive behavior is thinking how to find appropriate resources and release by various means, and try to expand influence to make university students in social network group participate in the services; the negative behavior is dealing with the problems of SNS passively, and the service is lacked of passion and power; undoubtedly, positive behavior or negative behavior will influence the participation behaviors and development direction of university students in SNS. By means of observation and accepting service, the university students also will make the decision being helpful to them based on actions of university library, and its strategy set is "participation or nonparticipation". The evolutionarily stable strategy (ESS) between participants will form in the mutual influence. Here K_i (i=1, 2) indicates the knowledge information service of university library positive and negative state; and R_i (i=1, 2) and C_i (i=1, 2) indicates the earning coefficients and cost coefficients of participants respectively. U_i (i=1, 2) indicates their own earnings when university library of participants provides information services negatively and university students don't participant in it, and $R_1 K_1$ and $R_2 K_1$ indicate their own earnings when university library of participants provides information services positively and university students participant in getting information. $C_i K_i$ (i=1,2) indicates cost of both sides. According to the above hypothesis and behavior dependency between participants, the payment matrix of both sides is shown in table 1:

TABLE 1 : Payment matrix for participation of both sides

University library	University students	
	Participation	**Nonparticipation**
Positive	$U_1 + R_1 K_1 - C_1 K_1,$ $U_2 + R_2 K_1 - C_2 K_1$	$U_1 - C_1 K_1, U_2$
Negative	$U_1, U_2 - C_2 K_2$	U_1, U_2

Among it, when the university library provides service negatively while university students take part in it, since the limit of providing resources restricts the service effect, the university students pay cost but without earnings, so the earnings is $U_2 - C_2 K_2$, and earnings of university library still is U_1. When the university library provides service positively while university students don't take part in it, because of inseparability of services, the university library pays cost, but overdue

knowledge information is too boring to state, which becomes the sunk cost. In this situation, the earnings of university library is $U_1 - C_1 K_1$, and earnings of university students still is U_2. When university library provides service positively and university students take part in it, the university library needs to pay the cost of delivering knowledge information and consultation, and university students need to pay the cost of absorbing and utilizing knowledge information. In this situation, earnings of both sides is $U_1 + R_1 K_1 - C_1 K_1$ and $U_2 + R_2 K_1 - C_2 K_1$.

Duplication Dynamics Equation of Game between University Library and University Students

Game is conducted between university library and university students by means of random pair, and the learning and strategy imitation of participants also is limited within groups. Suppose that the probability for librarian of choosing positive strategy is p, and then the probability of choosing negative strategy will be $1 - p$; the participation probability of university students is q, and then the probability of nonparticipation will be $1 - q$. The earnings of university students choosing to participate in strategy is $E_2^1 = p(U_2 + R_2 K_1 - C_2 K_1) + (1 - p)(U_2 - C_2 K_2)$. The earnings of choosing to give up participation is $E_2^2 = pU_2 + (1 - p)U_2 = U_2$. And then the average earnings of university students is $E_2 = qp(R_2 K_1 - C_2 K_1 + C_2 K_2) - qC_2 K_2 + U_2$. The duplication dynamics equation is

$$dq / dt = q(1 - q)[(p - 1)C_2 K_2 + p(R_2 K_1 - C_2 K_1)] \tag{1}$$

In a similar way, the duplication dynamics equation of librarian is

$$dp / dt = p(1 - p)(R_1 K_1 q - C_1 K_1) \tag{2}$$

The above differential equations describe evolutionary process jointly.

TABLE 2 : Regional stability analysis of system

	Condition	Number of eequilibrium point	Eequilibrium point	det J	trJ	Result	Phase diagram
Situation 1	$R_1 < C_1$, $R_2 < C_2$	4	(0, 0)	+	-	ESS	1
			(1, 0)	-	0	Saddle point	
			(0, 1)	-	0	Saddle point	
			(1, 1)	+	+	Instability	
Situation 2	$R_1 < C_1$, $R_2 > C_2$	4	(0, 0)	+	-	ESS	2
			(1, 0)	+	+	Instability	
			(0, 1)	-	0	Saddle point	
			(1, 1)	-	0	Saddle point	
Situation 3	$R_1 > C_1$, $R_2 < C_2$	4	(0, 0)	+	-	ESS	3
			(1, 0)	-	0	Saddle point	
			(0, 1)	+	+	Instability	
			(1, 1)	-	0	Saddle point	
Situation 4	$R_1 > C_1$, $R_2 > C_2$	5	(0, 0)	+;	-;	ESS	4
			(1, 0)	+;	+;	Instability	
			(0, 1)	+;	+;	Instability	
			(1, 1)	+;	-;	ESS	
			(p^*, q^*)	-	0	Saddle point	

Note: $p^* = C_2 K_2 / (C_2 K_2 + R_2 K_1 - C_2 K_1)$, $q^* = C_1 / R_1$

Analysis on Evolutionary Model

From equation 1, it can be seen when $q = 0, 1$ or $p = C_2 K_2 / (C_2 K_2 + R_2 K_1 - C_2 K_1)$, the participation probability of university students has stability. Similarly, when $p = 0, 1$ or $q = C_1 / R_1$, the probability of positive librarian has stability. The joint analysis of both sides can get 5 eequilibrium points. Since the stability for equilibrium points of evolution dynamic state can be got from regional stability analysis, and the regional stability can be got from jacobian matrix of evolutionary system. The jacobian matrix of above system is

$$J \begin{pmatrix} (1-2p)(R_1 K_1 q - C_1 K_1) & p(1-p)R_1 K_1 \\ q(1-q)(C_2 K_2 + R_2 K_1 - C_2 K_1) & (1-2q)[(p-1)C_2 K_2 + p(R_2 K_1 - C_2 K_1)] \end{pmatrix}$$

For evolution system, if and only if the determinant of matrix J is larger than 0 and the trace of matrix J is smaller than 0, the equilibrium point of ESS is stable, so the condition for stability of ESS of equilibrium point is related with R_i and C_i. According to relative size of R_i and C_i, the stability analysis result of each equilibrium point in 4 situations is shown in table 2, and the relative phase diagrams are shown in Figure 1, 2, 3 and 4.
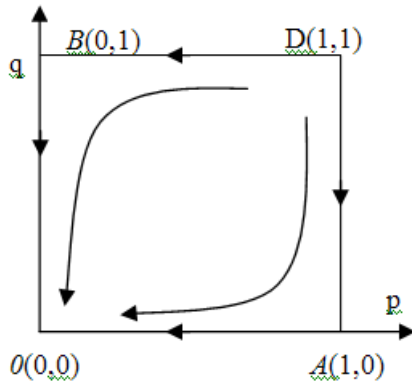

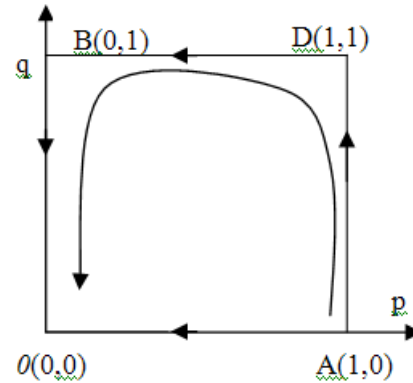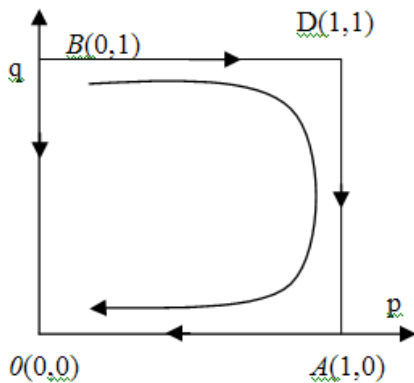**Figure 1 : Dynamic evolution process of system** （$R_1 < C_1 , R_2 < C_2$）

Figure 2 : Dynamic evolution process of system （$R_1 < C_1 , R_2 > C_2$）

Figure 3 : Dynamic Evolution Process of System （$R_1 > C_1 , R_2 < C_2$）
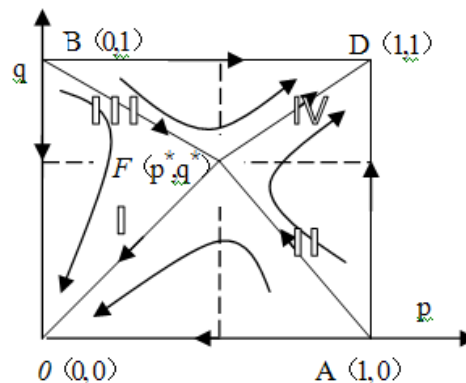

Figure 4 : Dynamic Evolution Process of System （$R_1 > C_1 , R_2 > C_2$）

In situation 4, $R_1 > C_1 , R_2 > C_2$, in table 2, the equilibrium points （0,0）and （1,1）are evolutionarily stable strategy (ESS). （1,0）and （0,1）are unstable eequilibrium points, (p^* , q^*) is saddle point, and above points are corresponding to point O, D, A, B and F in figure 5. Thereinto, the saddle point divides figure 4 into 4 districts I, II, III and IV, and the size of each district is determined by payment in game of both sides and size of saddle point value decided by situation of knowledge information management. Within scope of district I, the system convergence will reach to state of negative university library and nonparticipation of university students, meaning 0 (0,0); Within scope of district N, the system convergence will reach to state of positive university library and participation of university students, meaning D (1, 1). While in district II and III, the state of system convergence depends on broken line connected by unstable equilibrium points A, B and saddle point F, and it is the boundary of evolution, showing different results of system convergence. Larger broken line at upper right shows the system convergence is to positive librarian and the participation probability of university students is higher. Larger broken line at bottom left shows the system convergence is to negative librarian and the participation probability of university students is lower. Since the system evolution needs a process, these two states will exist simultaneously in system for a long time.

The above 4 situations show the result will be different when the earnings of participants and cost are different under the same situation of establishing SNS. In order to make the system evolution reach to positive result, the further discussion on changes of each parameter of payment matrix being relative to participants in system evolution will be necessary to be conducted.

FURTHER ANALYSIS ON PAYMENT OF PARTICIPANTS AND KNOWLEDGE INFORMATION MANAGEMENT

University students

In figure 4, the area of quadrangle ADBF $S = 1 - 1/2 * [C_2 K_2 / (C_2 K_2 + R_2 K_1 - C_2 K_1) + C_1 / R_1]$ shows that increase of earnings coefficient and decrease of cost coefficient for university students will enlarge the area of S, which means if the system is convergent and librarian is positive, the participation probability of university students will be high. Thereinto, the cost coefficient is related to searching, absorption and application of knowledge information. Because of rapid development of SNS technology, the cost of getting knowledge information reduces gradually, which causes misunderstanding in some university libraries, for example, some administrator think that university students will follow it automatically, and resources controlled by library will transform to the learning resources of university students continually as long as SNS is established. In fact, value discovery function of knowledge information is more important, except improving the information awareness and retrieval capability of knowledge information by all manner of means, university students also should pay more attention on absorb and apply the knowledge information dispersing in SNS by fragment way, that requires university students to cultivate abilities of utilizing information, and improve related earnings coefficient of knowledge absorption and transformation. The university library may grasp the characteristic and principle for demands of university students, guide university students by means of developing information retrieval, common required courses and lectures on Chinese-foreign databases utilization. In addition, the participation of a certain number of university students is the base and guarantee for development of SNS in university library, therefore, coordination and motivation on participation of students is very important, it is necessary to strengthen marketing publicity of SNS to attract attention of university students, and develop rich services to make SNS play more advantages in learning and contacting schoolmates and promote the expansion of user group of university library.

University Library

Similarly, the other side of game is university library, the increase of its earnings coefficient and decrease of its cost coefficient also will cause SNS tending to be active. Since the game is conducted by random pair in component group member, so the service quality will be different caused by different person, different time and different places, which makes SNS have important connotation centered with librarian. The knowledge information for study and communication has the certain quality requirement, although cost for arrangement, publication and delivery of knowledge information is low, the cost for librarian who uses professional knowledge technology to engage in collection, treatment and consultation is high, and restriction on public welfare of earnings also causes the interest balance of librarian, therefore higher professional quality good professional dedication is required for SNS librarian. Additionally, the present SNS in most of university libraries only uses the content release system of sharing information, knowledge query is often inadequate, which causes the degradation of service quality. Therefore, in the process of SNS, the interest and improvement on abilities of librarian shall be valued, because the improvement of service quality in most situations needs academic quality and mentality of participants, the initiative and creativity of librarian should be mobilized while pursuing public value, which will be conducive to continuous improvement of service quality.

Knowledge Information Management

As the platform of knowledge information service, the process of social network service is the process of continuous update for various kinds of knowledge information, and simply information supply and consultation answer have not fulfilled the requirements. As a platform, SNS will play a role of learning and communication better as long as add knowledge content continuously and strengthen information service rapidly. K_1 and K_2 reflect the developing evolution from low level to high level of SNS knowledge information management with the change of time. From $S = 1 - 1/2 * \{1/[1 + (R_2 - C_2)/C_2 * (K_1 / K_2)] + C_1 / R_1\}$, easily get first derivative of S to K_1 / K_2 is greater than zero, so when K_1 / K_2 is enlarged, the area of quadrangle ADBF will be enlarged, the probability of system convergence at D point will be larger, which means that knowledge information service in high quality will attract more university students to participate in SNS activities, and make SNS became the space and platform of gathering popularity, create more interests for university library as well. While the normative, active management and timely, accurate knowledge consultation will be conducive to ordering and elaboration of knowledge information and enhance the level of SNS management steadily, create larger value for university library as well.

CONCLUSION AND SUGGESTIONS

When university students enter into the university library to start SNS, they always only want to search for valuable information or know some friends, after the basic demand is solved, they will expect SNS to solve their problems timely, in

other words, the demand of university students changes continuously. In consideration of these differences, university library will attract participation for a large number of university students as long as it provide distinctive service in good time, and make it become the online home for students' communication.

The passion and knowledge level of librarian has the positive correlation with attraction of SNS and it will deeply influence the result of service, so in order to make SNS be more attractive and fashionable, it is necessary for administers to design the certain incentive mechanism of librarian, and strengthen this kind of incentive by some reward methods. The librarian with high quality and participants are willing to take part in various activities held by SNS through various reward methods, which has the positive meaning for improving the service quality of SNS and strengthening the utilization of library resources undoubtedly.

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