Research on university culture construction in the view of ecological idea

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ABSTRACT: With the progress of times, our spiritual pursuit becomes higher and higher, and it is especially true among modern youth. Therefore, establishment of university culture has gradually become the focus of attention. This paper firstly quantized university culture construction into four parts: material culture construction, spiritual culture construction, system culture construction, and behavioral culture construction. It then analogized each part as one population in ecological system; established multi-population ecological model; and analyzed the interactional relations between each part. At last, this paper reached conclusions based on multi-population ecological model and analyzed the correlations among various factors of university culture construction, so as to obtain a comprehensive, scientific and healthy scheme for university culture construction.

Keywords: university culture construction; multi-population ecological model; analogy method; sustainable development

1 INTRODUCTION

With the advance of history, university culture construction in our country is in continuous expansion and improvement. In combination of the ecological sustainable development concept of contemporary hot issues, researchers of university culture are striving to find a healthy and sustainable mode for university culture development. In the writer's mind, this sustainable development mode is actually a development mode in accordance with ecological concept. Therefore, this paper conducted research on the development of university culture construction in view of ecological concept. According to the university culture construction under ecological idea, many previous scholars have made great contribution, among which:

In 2015, Lianrong Dai made comprehensive analysis of the construction frame of university ecology by combining cultural ecology perspectives and methods in *Intergrowth and Construction of Culture and Personality*. His core viewpoint is to emphasize that it is necessary to establish development environment in which inside and outside ecological balance of universities can be built to motivate life potential and personality while respecting knowledge and guard the awe to knowledge [1].

In 2013, Wenxiang Guan set forth the concept of ecological campus and confirmed construction of ecological campus in *Research on Ecological Campus Construction of Fujian Agriculture and Forestry University*. He took Fujian Agriculture and Forestry University as an example and made deep analysis of the existing problems in campus landscaping, water transformation, and ecological road. He proposed optimization measures for Fujian Agriculture and Forestry University and has made great contribution to university culture construction [2].

In 2011, Xueqin Liu set out the connotation of ecological construction of culture in *Research on Cultural Ecology of Harmonious University Campus Construction*; and divided the construction of harmonious campus into four levels: man and society; man and nature; man to man; man and himself. Through in-depth study, he proposed the countermeasure for internal cultural & ecological harmony and that for external cultural & ecological harmony [3].

In 2011, KetaoYang took ecological civilization concept as the guidance and used systematical analysis method to summarize the modest and ecological wisdom contained within our traditional culture in *Research on Ecological University Construction under Ecological Civilization Concept*. He discussed the natural environment, ecological culture and management of ecological university campus, trying to estab-

lish theoretical system of ecological university construction and looking for the era significance in constructing ecological university [4].

Based on predecessors' studies, this paper quantized university culture construction into four parts: material culture construction, spiritual culture construction, system culture construction, and behavioral culture construction. Then, it analogized each part as one population in ecological system; established multi-population ecological model; and analyzed the interactional relations between each part. At last, this paper reached conclusions based on multi-population ecological model and analyzed the correlations among various factors of university culture construction, so as to make contribution to the construction of university culture in China.

2 QUANTITATIVE ANALYSIS OF UNIVERSITY CULTURE ELEMENT

In recent times, a harmonious, environment-friendly and sustainable development pattern is a pursuit in each industry. It is also a pursuit in university culture construction. The author thinks the sustainable development pattern is actually a development pattern that follows ecological concept. Therefore, this paper conducted research on the development of university culture construction in view of ecological concept. In China, research on university culture construction originated from late 1980s. As age advances, more and more colleges and universities start paying attention to university culture construction, and our university culture construction is in continuous improvement and expansion. However, many new problems have emerged because of the shock caused by market-oriented economy. For example, many schools are in a rush for quick results and compete in expansion. As a result, various luxury buildings can be found in colleges and universities now. Nevertheless, these reinforced concrete products cannot manifest the cultural deposits of a university. In spiritual aspect, the impetuous style of study, academic misconduct and excessive commercial atmosphere have impeded the development of university culture to a great extent.

It seems university culture construction have reached its bottleneck. Thus, the author conducted research on the development of university culture construction in view of ecological concept. Ecological concept refers to human's concepts on the ecological development and ecological protection of natural environment and social environment. It emphasizes on the harmony between man and nature. This paper studied university culture construction through 'ecological concept' of which the implication is to ensure the harmonious development between each element of university culture, so as to achieve common progress and obtain sustainable development of university culture.

The ecological concept hypothesis of 'university culture' can be understood from three levels: one is the ecologicalization of internal university environment; another is the ecologicalization of the relation between internal university environment and external university environment; the last one is the ecologicalization of educational objectives and approaches. This paper mainly studied the ecologicalization of internal university environment. It quantized university culture construction into four parts: material culture construction, spiritual culture construction, system culture construction, and behavioral culture construction. It then analogized each part as one population in ecological system. Development of all populations is in mutual restriction and mutual promotion. It constitutes the autonomous and sustainable development of ecological system. After finding the optimal ecological development pattern, what we shall do is realize construction maintenance in combination of ecological rules; and then, free it in development instead of entirely relying on investing capitals, management and human resources in development. Ecological population models are in further need of establishment to figure out the specific relation between each population and the best scheme to obtain the optimal development pattern, aiming to constitute healthy and sustainable development.

3 ESTABLISHMENT OF ECOLOGICAL POPULATION

In the entire ecological system, populations are always in mutual competition and correlative dependence to realize continuous progress. As a result, the biological quantity inside a biological population always changes correspondingly. In order to study the relation between each population, solution channel can be found through mathematical theories and formulas, such as statistics and differential equation. Development, utilization and protection of population and ecological environment can be realized by uncovering ecological phenomena through mathematical theories.

3.1 *Ecological model of single population*

In nature, each population is in one level of biosphere which can be analogized that each element of university culture is in the tremendous and complex social environment of China. Single population refers to individual of the entire ecological system. Thus, ecological law of single population must be clarified so as to make it convenient to understand more complex ecological systems.

In 1789, British scientist Malthus proposed the famous population model given as follows:

$$x(t + \Delta t) - x(t) = bx(t)\Delta t - dx(t)\Delta t \qquad (1)$$

Among which, $x(t)$ refers to the gross population at t moment; d refers to mortality rate; and b refers to birth rate.

Divide the left part of Formula (1) by Δt and set $\Delta \to 0$, then:

$$\frac{dx}{dt} = (b-d)x = rx \tag{2}$$

Among which $r = b\text{-}d$ refers to growth rate. Formula (3) as shown below can be solved in combination of $r = b\text{-}d$ and differential equation knowledge:

$$x(t) = x(0)e^{rt} \tag{3}$$

Resolve the limits on both sides of Formula (3), then Formula (4) given as below can be obtained:

$$\lim_{t \to +\infty} x = \lim_{t \to +\infty} x(0)e^{rt} = \begin{cases} 0 & r < 0 \\ x(0) & r = 0 \\ \infty & r > 0 \end{cases} \tag{4}$$

According to Formula (4), it can be known that regardless of how little r is, the population quantity will go towards infinity as long as r is greater than zero. However, the above conclusion does not match the actual situation, meaning there's limitation in Malthus's theory. In order to better fit the development law of natural ecology, Vethust considered the situation that populations would not develop infinitely; and proposed the well-known Logistic model as shown in Formula (5) given below:

$$\frac{dx}{dt} = rx(1 - \frac{x}{K}) \tag{5}$$

Among which, K refers to the maximum bearing capacity of environment. Formula (6) shown as follows can be obtained in combination of differential equation knowledge:

$$x(t) = \frac{Kx(0)}{x(0) + (K - x(0))e^{-rt}} \tag{6}$$

Conduct derivation on Formula (5) again to obtain:

$$\frac{d^2x}{dt^2} = r^2 x(1 - \frac{2x}{K})(1 - \frac{x}{K}) \tag{7}$$

When $x=K/2$, inflection point will occur on system track. When $x<K/2$ and $\frac{d^2x}{d^2t} > 0$, populations are in rapid increase; when $x>K/2$ and $\frac{d^2x}{d^2t} < 0$, populations are in rapid reduction. Therefore, in combination of population growth model, population quantity increase can be divided into five phases: 1. Incubation period--population quantity is little and growth rate is low;

2. Acceleration period--population quantity gradually increases while population growth rate is accelerating; 3. Transformation period--population quantity reaches $K/2$ moment and growth rate reaches its maximum value; 4. Slowing-down period--population quantity goes beyond $K/2$ moment and growth rate slows down; 5. Saturation period--population quantity reaches the maximum bearing capacity of environment and population quantity is saturated. From the above conclusions, it can be known that population quantity will not develop infinitely. It will be saturated due to influence brought by many factors such as environment. The same situation also occurs in university culture construction. University culture construction is limited by environment and university culture will slow down in expansion after reaching a certain phase. At that moment, reform in scheme will be in need to change the environment that university culture is in, so as to help university culture adapt to the current atmosphere and obtain further rapid development. There's only progressive tense but no perfect tense in reform. At present, our country is in rapid development. Its cultural background and propagation change time after time. Therefore, reform in university culture construction shall be in progress correspondingly. We shall discard the dross and select the essential to make it adapt to the change of the era.

In combination of Formula (7), it can be known that there's defect in Logistic model--when population quantity reaches a large number, population growth rate can be negative--as a result, the addition of Allee effect can help obtain a more reasonable growth model:

$$\frac{dx}{dt} = rx(1 - \frac{x}{K})(\frac{x}{N} - 1) \tag{8}$$

Among which, N refers to the sparse constant of population and $K > N > 0$.

If $0<x<N$ and $rx(1\text{-}x/k)(x/N\text{-}1)<0$, it means negative growth occurs in population when population quantity is little.

If $x>K$ and $rx(1\text{-}x/k)(x/N\text{-}1)<0$, it means population quantity is large; population growth rate is positive and it will be close to K at last.

If $N<x<K$ and $rx(1\text{-}x/k)(x/N\text{-}1)>0$, it means population quantity is within (N, K) and population growth rate is close to K.

3.2 *Establishment of multi-population ecological model*

In nature, there are certain relations among many biological populations. These relations can be divided into three categories: benefit-oriented relation, harm-oriented relation, and neutral relation. Predator-and-bait relation means one population takes another/other population(s) as its food such as wolf and sheep. After long-term survival and reproduction, they

have maintained dynamic balance. Competition relation means populations compete with each other for food or survival room. During continuous competition, populations will evolve and become stronger. Mutualism relation means populations depend on each other, such as algae and fungus. Once they leave the other, they cannot survive any longer.

The predator-and-bait model proposed by Italian mathematician in research on fishery resources is as follows:

$$\begin{cases} \dfrac{dx}{dt} = ax - by \\ \dfrac{dy}{dt} = cxy - dy \end{cases} \tag{9}$$

Conduct three steps of simplification to the above model: predator catches bait by linear mode *bxy*. If there is no bait, predator will die in exponential form. The conversion ratio of predator digesting bait is *k=c/b*. The trend chart of the vector fields of predator and bait is shown in Figure 1 as follows:
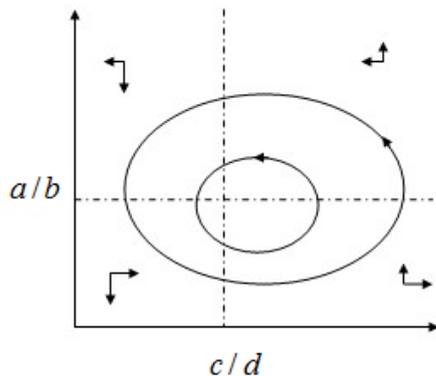

Figure 1. Trend chart of vector fields

As predator and bait are zero when the equilibrium point is at the origin, the vector field equation can be simplified as:

$$\begin{cases} a - by = 0 \\ cx - d = 0 \end{cases} \tag{10}$$

According to analysis of Figure 1, it can be known that the system track does anticlockwise rotation around the equilibrium point and forms a closed curve. The system track can well accord with the actual situation such as recurrent locust disaster. In combination of the benefit-oriented relation, harm-oriented relation and neutral relation among populations as mentioned above, it can be known that besides predator-and-bait relation among populations, there are competition relation and mutualism relation. In the next step, we shall consider density dependent factor to obtain Formula (11) as follows:

$$\begin{cases} \dfrac{dx}{dt} = x(A + A_{11}x + A_{12}y) \\ \dfrac{dy}{dt} = y(B + A_{22}y + A_{21}x) \end{cases} \tag{11}$$

Among which, A_{11} and A_{12} refer to the dependent coefficients inside single population. In most cases, they are negative numbers and this phenomenon accords with the competitive situation for room inside population. When $A_{12} < 0$, $A_{21} > 0$, the model is a predator-and-bait model. When $A_{12} < 0$ and $A_{21} < 0$, the model is a competition model. When $A_{12} > 0$ and $A_{21} > 0$, the model is a mutualism model.

In Formula (9), the predation function is a linear function *bxy*. However, when bait quantity is too large, it is unreasonable to eat bx baits in unit time. Thus, functional response predation-and-bait model as follows has been proposed:

$$\begin{cases} \dfrac{dx}{dt} = x(r - kx) - a\phi(x)y \\ \dfrac{dy}{dt} = b\phi(x)y + y(-s - \delta y) \end{cases} \tag{12}$$

Among which, $\phi(x)$ refers to functional response function. According to functional response function, the expression means for functional response functions of different populations are widely divergent. See Formula (13) given below for the expression of the functional response function of invertebral animals:

$$\phi(x) = \frac{ax}{1 + bx} \tag{13}$$

The functional response function of vertebral animals is as follows:

$$\phi(x) = \frac{mx}{b + x^2} \tag{14}$$

According to the university culture element described in this paper, the functional response function expression of university culture can refer to that of vertebral animals shown as Formula (14).

With human development and environmental destruction, more attention shall be paid to the sustainability, health and biologic chain effect of biological system. Therefore, many scholars are considering yield rate and invest rate. Predation-and-bait ecological population model proposed by F.Brauer is quoted in this paper:

$$\begin{cases} \dfrac{dx}{dt} = xf(x,y) - H \\ \dfrac{dy}{dt} = yg(x,y) - G \end{cases} \tag{15}$$

Among which, *H* and *G* refer to constant yield rates ($H \geq 0$, $G \geq 0$) or constant invest rates ($H \leq 0$, $G \leq 0$). $f(x,y)$ and $g(x,y)$ refer to relative growth rates of predator and bait. In the next step, research shall be made on the bait constant yield rate with function response function of predation-and-bait model:

$$\begin{cases} \dfrac{dx}{dt} = rx(1-\dfrac{x}{k}) - \dfrac{\beta x^2 y}{x^2 + a} - H \\ \dfrac{dy}{dt} = -dy + \dfrac{c\beta x^2 y}{x^2 + a} \end{cases} \quad (16)$$

In combination of Formula (15) and differential equation qualitative theory, it can be known that equilibrium point is the condition for global asymptotic stability. When internal equilibrium point is unstable, there's at least one stable limit cycle in the system. To sum up, it is very important to consider shelter and yield rate in the biological model. Therefore, in the next step, predation-and-bait model of linear functional function, bait shelter, and linear yield rate shall be established as shown in Formula (7):

$$\begin{cases} \dfrac{dx}{dt} = rx(1-\dfrac{x}{k}) - a(x-m)y - px \\ \dfrac{dy}{dt} = (b(x-m)-d)y - qy \end{cases} \quad (17)$$

Among which, paraphrases of *x*, *y*, *r*, *k* and *d* are the same with those mentioned above. *a* and *b* refer to predation coefficients while *px* and *qy* refer to linear yield. As there's bait shelter rate in Formula (17), $x>m$ and the system has uniform bound in $\Omega = \{(x,y)|x>m, y>0\}$. See the following for specific uniformity relation. Set $W=x+ay/b$ and derive both sides of the equation by time. Thus, the following formula can be obtained by bringing Formula (17):

$$\frac{dW}{dt} = \dot{x} + \frac{a}{b}\dot{y} = rx(1-\frac{x}{k}) - a(x-m)y - px + \frac{a}{b}(b(x-m)-d)y - \frac{aq}{b}y$$

$$= rx(1-\frac{x}{k}) - px - \frac{a(d+q)}{b}y \quad (18)$$

Set $\beta = d + q$ and combine dW/dt calculation method to obtain:

$$\frac{dW}{dt} + \beta W = -\frac{r}{k}x^2 + (\beta + r - p)x \quad (19)$$

The right end of Formula (19) is a quadratic function with open side down. When $x = k(\beta+r-p)/2r$, $dW/dt + \beta W$ reaches its maximum value:

$$\frac{dW}{dt} + \beta W \leq \frac{k}{4r}(\beta + r - p)^2 < \mu \quad (20)$$

Among which, if $\mu = k(\beta+r-p)^2/4r+1>0$, $dW/dt+\beta W<\mu$ and the following inequation can be obtained:

$$0 < W < \frac{\mu}{\beta}(1 - e^{-\beta t}) + W(x(0), y(0))e^{-\beta t} \quad (21)$$

In Formula (21), set $t \rightarrow 0$, then we can have $0<W<\mu/\beta$, which can prove there's uniform bound in the solution of Formula (17) and predators and baits are in long-time coexistence in Ω.

4 CONCLUSION ANALYSIS OF MODEL

Ecological idea of university culture shall start from teaching method and the interaction of humanity ecological environment. Reflected between teacher and student, humanity ecological concept is to establish and improve regulatory framework; implement administrative provisions; construct harmonious campus; and create sustainable humanity ecological atmosphere. However, it can be seen from the conclusions obtained from the multi-population ecological models that there are many problems existing in the university culture construction of our colleges and universities. Top-layer integrated planning under ecological idea is absent. The problems of major decisions and schemes have led university culture construction to a tortuous path. The construction of campus material culture is short of layout structure adjustment under strategic perspective and lack of cultural deposits and cultural atmosphere.

Compared with prestigious universities overseas, our universities can learn from their material culture construction, spiritual culture construction, system culture construction and behavior culture construction. Take the famous Harvard University as an example. The material culture construction of Harvard University is manifested in its environment construction of which there is one distinct feature—openness. In the spiritual culture construction of Harvard University, being realistic and pragmatic is the core. For several hundred years, Harvard University has inherited its school motto and our universities can also learn to grant such a high status to their school mottos. In system culture hypothesis, system of curriculum and teaching, system of donation and fund, and system of democratic principal election conducted by alumni association can all be learnt by us. For the convenience of construction behavior culture, Harvard University has a rich mixture of behavioral culture activities. Students are allowed to do different studies and improve their comprehensive capacities. All these activities have make university culture colorful with prosperous development.

5 CONCLUSIONS

This paper made an analysis of university culture construction in combination with sustainable development

concept of ecology. It quantized university culture construction into four parts: material culture construction, spiritual culture construction, system culture construction, and behavioral culture construction. It then analogized each part as one population in ecological system; established multi-population ecological model; and offered guidance on university culture construction from ecological perspective, so as to promote the sustainable development of the university culture construction in China.

The main problems of the university culture construction in China are major decisional and programmatic problems which lead university culture construction to a wrong direction, resulting in insufficient overall structural layout regulation from strategic perspective and lack of cultural deposits and atmosphere. Compared with Harvard University, there're many things we need to improve and learn from Harvard. It is expected that domestic colleges and universities can engage in advanced studies of colleges and universities abroad; and turn what they learn into practice.

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