Mathematical theory development model in public sports education for university students

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Abstract

This paper aims to study the development model of public sports education, explore the factors that lead the development of public sports education, and give suggestions and measures. Firstly, by analyzing the situation of public sports in a university with literature method and questionnaire method, the paper explores the factors affecting the development of public sports. On this basis, according to mathematical theory, this paper takes organizational theory as the basis and uses Logistic model to analyze the sustainable development of public sports. This paper points out that the sustainable development of sport education system is characterized by its fairness, sustainability, commonality, time sequence, spatiality and identifiability, while it is realized by the rational use of rise and fall. Rational use of rise and fall mainly relies on teachers' leading of students and development of rich sports education scenarios. The scope of investigation in this paper is limited and the data does not fully reflect the development situation of public sports of all university students. The more comprehensive investigation and the establishment of a better model will provide more improvement suggestions for public sports education development.

Keywords: university students, public sports, mathematical theory, logistic model, development

1 Introduction

The questionnaire method with "random sampling" and "non-random sampling" is used in a university, and the data obtained is summarize into table and figure for analysis [1, 2].

1.1 ATTITUDES TOWARDS AND PURPOSE AND MOTIVATION OF SPORTS PARTICIPATION BY UNIVERSITY STUDENTS

It can be seen from Table 1, the sum of proportions of "probably like" and "like" is 63.9% of the total. For the remaining 36.1% of population, their attitudes towards sports can be changed by improving sports environment, active guidance, education and other means.

TABLE 1 Questionnaire of university students' attitudes towards participation in sports

Attitude	Frequency	%
Like	607	45.6
Probably like	243	18.3
Average	206	15.5
Kind of dislike	150	11.3
Dislike	124	9.3
Sum	1330	100

1.2 MAIN WAYS AND CAUSES OF PARTICIPATION IN EXTRACURRICULAR SPORTS

As shown in Table 2 and Table 3, the majority of university students participate in sports through real sports experience. The reasons why university students select "indirect participation" are mainly concentrated in "hobbies and interests, small physical output, lack of sport field and facilities, and large time elasticity". There are a large number of university students selecting "direct participation", so colleges and universities should ensure education and guidance, motivate and cultivate students' interest in sports, and make them directly participate in sports [3].

TABLE 2 Questionnaire of main ways of participation in sports

Participation way	Frequency	%
Direct participation	484	36.4
Indirect participation	563	42.3
Both	283	21.3
Sum	1330	100

Notes: Direct participation: individuals personally participate in sports.
Indirect participation: watch others do sports, for example, watch live sports or watch sportscasts

TABLE 3 Questionnaire of causes of participation in sports

Causes of indirect participation	Frequency	%
Lack of sport field and facilities	222	39.4
Small physical output	257	45.6
Strong sense of appreciation	128	22.7
Large time elasticity	185	32.8
Low costs	103	18.3
Hobbies and interests	318	56.5
Others	74	13.2

The motivations of our students can be seen in Figure 1. From the data we can see their motivations are different, they can participate in sports according to their own value recognitions and needs.

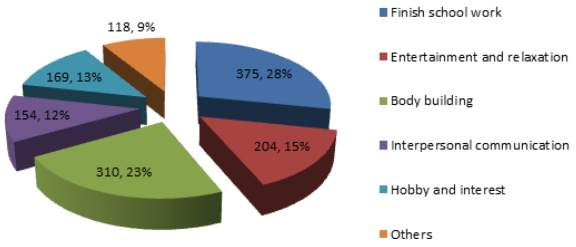

FIGURE 1 Motivations and purposes of participating in sports

1.3 FREQUENCY OF PARTICIPATION IN EXTRACURRICULAR SPORTS

The data in Table 4 is sports participation situation of university students after sports education classes. Most of them do sports once or twice a week.

TABLE 4 Frequency of participation in extracurricular sports

Sports frequency (time/week)	Frequency	%
0	154	11.6
1-2	829	62.3
≥3	282	21.2
Sometimes, irregular	65	4.9
Sum	1330	100

1.4 SELECTION OF EXTRACURRICULAR SPORTS PROGRAMS BY UNIVERSITY STUDENTS

As can be seen from Figure 2, the extracurricular sports of university students are mainly concentrated in basketball, football, volleyball, table tennis, badminton and tennis. The main reason is that the public sports education course of universities in this area is ball-oriented. The reconstructed ball fields and facilities provide convenience for sports education and extracurricular activities. 539 students select "running", accounting for 40.5%. On the one hand, running is not limited by field and facility; on the other hand, its arrangement is flexible. The proportions of students selecting "swimming, martial arts and art of attack" are small. The main reasons are the limit in field and facility as well as the features of sports programs. In the sports programs, 489 students select "dancing and aerobics", accounting for 36.8%, next to running. Obviously, sports programs such as "dancing and aerobics" are gradually preferred by university students. On the one hand, they are less limited by field and facilities; on the other hand, they have the function of body shaping and building. They are the programs that are highly frequently selected by many female university students [2-6].

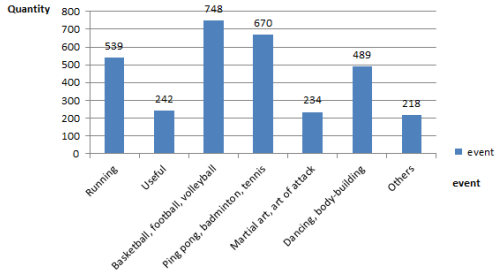

FIGURE 2 Investigation of extracurricular sports programs by university students

1.5 MAIN SPORT CONSUMPTIONS AND CONSUMPTION LEVELS OF UNIVERSITY STUDENTS

As shown in Figure 3 the sports cultural environment is harmonious and the sports atmosphere is strong in this area. The sports programs such as badminton, basketball and tennis are actively carried out, which stimulates students' consumption of sports equipment and skills training. In addition, in this region, major sports events and sports performance are held, which potentially stimulates students' consumption of watching them [5-7].

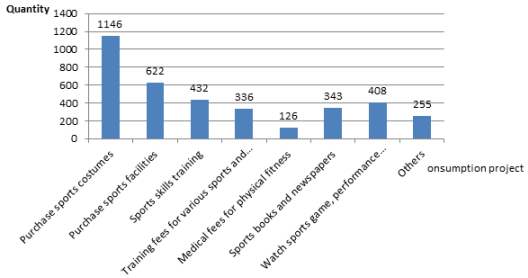

FIGURE 3 Investigation of main sports consumptions of university students

Table 5 reflects the sports consumption conditions of university students in this area. The consumption level is concentrated in 150 yuan/month or less.

TABLE 5 Sports consumption conditions of university students

Consumption level (yuan/month)	Frequency	%
Below 50 yuan	286	21.5
50-100 yuan	472	35.5
100-150 yuan	314	23.6
150-200 yuan	114	10.8
Over 200 yuan	114	8.6
Sum	1330	100

1.6 FACTORS AFFECTING PARTICIPATION OF UNIVERSITY STUDENTS IN SPORTS

It can be seen from the data in Figure 4, the major three factors affecting participation in sports are as follows: the first one is "sports field and facility", selected by 1,112 students, accounting for 83.6% of surveyed population, ranking the first among all factors. The second one is "professional guidance", selected by 915 students, accounting for 68.8%. The third factor is "training atmosphere", selected by 488 students, accounting for 36.7%. Other factors are "sports interest", selected by 383 students, accounting for 28.8%, "leisure time", selected by 336 students, accounting for 25.3% and so on. By analyzing the above results, though factors of the university students' account for a certain proportion, the sports environment factor of universities and colleges should be the important factor that affects students' participation in extracurricular sports [8, 9].

2 Summary of relevant factors affecting public sports development

According to investigation contents in the previous chapter, obviously, sports science, technology, and local economic development level play key influential roles in the development of public sports. Models are established for these three factors in the following part:

$$S = S_0 e^{\lambda t}, \tag{1}$$

where S is quantity of sports knowledge with the quantity of scientific journals and papers as the unit of measurement. t is time, λ is constant. S_0 is quantity of sports knowledge in the initial period.

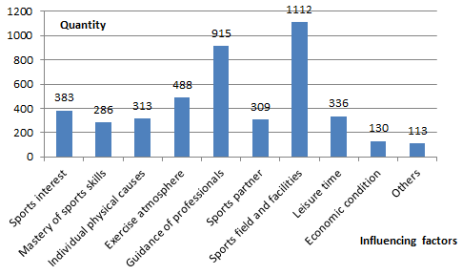

FIGURE 4 Investigation of factors affecting participation in extracurricular sports

When a country or a region introduces or absorbs foreign advanced technology or improves and enhances the existing technology, it should depend on the increase its scientific knowledge level to achieve the desired economic benefits. The law of increase in the quantity of advanced technology introduced or absorbed is doubling. The mathematical model is as follows:

$$A = A_0 e^{\lambda t}, \tag{2}$$

wherein: A is quantity of advanced sports technology introduced. t is time. λ is constant. A_0 is quantity of technology in the initial period.

According to the investigation in the previous chapter, local economic growth can drive the development of public sports. The general growth model is used:

$$Y = kA^{\alpha} K^{\beta} L^{\gamma} \tag{3}$$

wherein: k, α, β, and γ are constants Y is economic growth. k is investment in scientific and technological progress. K is fixed capital input, and L is labor input [10].

3 Model design

Logistic model is an important tool of using self-organization theory to study complex systems and systems of sustainable development. In recent years, this model has been successfully applied in sustainable development of regional economy and social system and ecosystem, which provides basis for the author to use this model to study the sustainable development of sports education system [11, 12].

Non-linear interaction between systems is the internal cause of the sustainable development of self-organization system. Therefore, Logistic model that describes this feature is also a non-linear differential equation. The typical Logistic model is as follows:

$$\frac{dx}{dt} = rx\left(1 - \frac{x}{M}\right) \tag{4}$$

From a mathematical point of view, Logistic model has two top solutions, namely, $x = 0$ and $x = M$. The former represents the initial state of system development in a Logistic development unit. The latter represents the final point of system development under the restriction of external environment. In this range, when $r > 0$, solution $x = 0$ is instable. When the system state slightly changes, x will increase ($dx > 0$), until $x = M$. However, this process is not a simple increasing function. By solving the extreme value of $\frac{dx}{dt}$, obtain the inflection point of X. By further solving three-order reciprocal, obtain the inflection point of $\frac{dx}{dt}$. Thus, divide X into four stages: initial stage of slow development, growth stage of rapid development, mature development at a high development speed but showing downward trend, and reduction stage at development speed gradually reducing to 0.

A Logistic development process can be expressed by Figure 5:

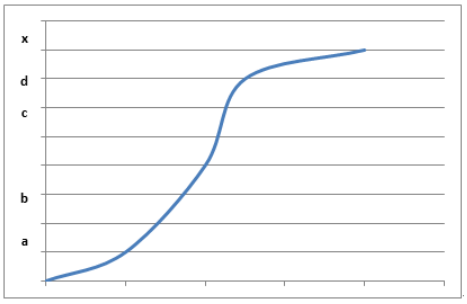

FIGURE 5 A logistic development unit

a, b and c in the figure respectively represent different inflection points, d represents the highest development state of system in a Logistic development unit.

Studies show that, what leads sports education system to constant self-organizing evolution is neither teacher nor student, but the order parameter beyond various sports education elements. If we understand the order parameter that leads sports education system to evolution as X, it is easy to see that, in the initial stage, the development of X is not quick. At this point, sports education is a process of constant mutual adaptation and adjustment of teachers and students, in which there is competition predicting various development prospects, or even showing a certain degree of confusion.

Once a sport mode (often manifested as teaching mode in line with students' physical and mental laws, and teaching content that can cause common interest) dominates in the competition, the synergistic effect will rapidly appear, the formation of order parameter will be obviously accelerating, other sport modes will quickly gather around the order parameter, and sports education

rapidly strides forward an order state.

Obviously, however, order parameter cannot randomly and immoderately develop, but it is restricted by many factors. First is the limit of individuals (teachers, for example) that occupy an important position in the formation of order parameter. Order parameter shows features that the local does not have, the established knowledge level and cognitive structure of teachers, but determines that other-dominant order parameter formed will not exceed too much. Second is external constraint. Schools are the important places for all levels of society to extend their ideologies. They exert influence by various methods. Therefore, order parameter of sports education system can grow in a permitted range. Thus, when order parameter develops to a certain stage, it and sports education led by it will be more and more largely restricted, so that the development speed drops. Finally, when the restrictive effect of restrictive factors and the pushing effect of dynamic factors of competition and cooperation reach a balanced state, order parameter will be stable in a determined level, and then sports education system will enter into a critical point. At this point, sports education system shows a feature of orderliness but imbalance [11-14].

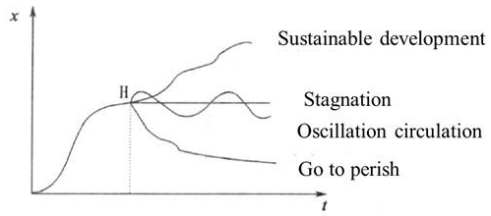

FIGURE 6 Model of self-organizing system development on the critical point

Sports education system completes a Logistic development unit, which does not mean that it is stable. At this point, it is on the H critical point as shown in Figure 6. It can be known from this that, the current sports education system is in the prelude of qualitative change. The system develops to a higher level. Continuing Logistic process to obtain sustainable development, or leading order parameter of the system to disintegrate, thus making the system return to the initial state or the terrible state of confusion, depends on the effect of rise and fall.

In order to lead sports education system to sustainable development, it is necessary to reasonably use and create favorable rise and fall.

Firstly, teachers should lead students to continue to increase openness, adjust and optimize themselves, keep away from equilibrium thought, actively introduce negative entropy flow, overcome positive entropy flow, get close to self-organizing state and promote sports education system structure to constantly change, in order to overcome and even transform limiting factors. This process is innovation [13].

Secondly, teachers should create a more colorful teaching scene; give full play to the effects of field and facilities, teaching contents and teaching methods, to provide students with a richer teaching with more imaginary spaces. Teachers should artistically grasp and define the innovative thinking and skills generated in the process of student's study. Teachers should fully give affirmation and help, so that these weak creative lights in the initial stage can grow stronger and stronger. Finally, through their internal non-linear mutual mechanism, they can extend, and form the huge rise and fall in thinking structure and capability, thus forming the qualitative leap [14].

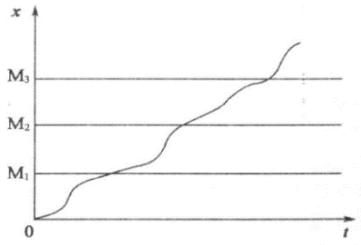

FIGURE 7 S-shaped evolution curve of sports education system

From the perspective of Logistic model, the self-organizing development process of sports education system "balance→ imbalance→ critical point" just completes a Logistic development unit. After sports education system breaks the critical point and completes qualitative change, new restriction factors and profit-generating factors will appear. For elements in the system, teachers or students, individual fields generated by them will change after a leap. Another round of competition and cooperation will continuously extend at a new level. Sports education system thus shows S-shaped development stance containing multiple stages, shown in Figure 7.

4 Conclusion

In addition to the factors of university students, the sports environment of universities and colleges is a major factor affecting participation in sports. Carrying out contests between universities and colleges, sports associations and clubs can provide a good platform for students to develop and cultivate sports interest, and motivate participation in sports.

However, what leads the development of sports system is order parameter beyond various sports education elements. The non-linear mechanism in public sports education system of universities and colleges promotes the system to constantly approach the critical point. Rational use and creation of rise and fall can make sports education system avoid oscillation, stagnation or recession, thus constantly and continuously developing towards a higher level. As Harken said, "the amazing thing in self-organizing system is that though supplying energy to the system in a completely random way, the system can form a well-defined macro mode".

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