A HEURISTIC SWARM INTELLIGENCE ALGORITHM FOR THE SHAPING OF INDIVIDUAL PSYCHOLOGY IN PHYSICAL EDUCATION

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Abstract

In the field of physical education, it is an important issue to shape individual psychology properly and improve the interest, ability and character of students. Therefore, this paper proposes a heuristic swarm intelligence algorithm for the shaping of individual psychology in physical education. According to the theories of educational psychology, the influence of the traditional teaching model for physical education was analyzed on the shaping of individual psychology. Then, the author demonstrated that the shaping of individual psychology could be promoted by the physical education teaching mode based on the proposed algorithm. Next, the differences between the traditional and our teaching modes were compared through two datasets. The results show that our teaching mode outperforms the traditional one in shaping the individual psychology of students in physical education. The results provide a new path to improve physical education through artificial intelligence.

Key words: Educational Psychology, Swarm Intelligence Algorithm, Physical Education, Individual Psychology.

INTRODUCTION

In order to better shape the individual psychology of students through physical education, so that their qualities in the aspects of interest, ability and character could be improved, based on an in-depth analysis of the relevant theories of educational psychology and the heuristic swarm intelligent algorithm in the field of artificial intelligence, this paper conducts in-depth research on the individual psychology shaping in physical education.

Previous studies on the shaping of individual psychology in physical education have yielded fruitful results. Some researchers analyzed the correlation between individual psychology and teacher-student interaction in physical education (Phillips, Carlisle, Hautala et al., 1985); some researchers studied the correlation between students' social psychosocial development and the teaching effect of physical education curriculum (Smith, Aicinena, & Steffen, 1994); Some researchers focused on interest research and studied the promotion effect of interest on learning outcomes by designing psychometric scales (Lonsdale, Sabiston, Taylor et al., 2011); Some researchers studied the influence of psychological avoidance on the final effect of teaching from a longitudinal perspective (Warburton & Spray, 2009); and some researchers analyzed the positive impact of students' active participation on the satisfaction of physical education modes (Perlman, 2010). In recent years, some researchers conducted in-depth study on the influence of emotional factors on the teaching effect of physical education (Turan, Bahadir, & Certel, 2015); some studied the relationship of motivation and physical education teaching effect from the perspective of self-motivation (Krijgsman, Vansteenkiste, Tartwijk et al., 2017). In addition, some researchers took PE teachers...
as the research subjects. For example, some researchers analyzed the influence of the reciprocal effect model on the teaching behavior of PE teachers (Marsh, Papaioannou, & Theodorakis, 2006); some researchers studied the academic success of candidate PE teachers from five personality dimensions such as emotion (Tok & Morali, 2009); some researchers analyzed the impact of self-cognitive ability on the normal development of teaching (Carraro, Scarpa, Gobbi et al., 2010). Although the predecessors have carried out a lot of research on the shaping of individual psychology in physical education, the research paths mostly adopted the traditional social scientific research methods, so there is still room for further improvement.

Among the above-mentioned research results, the main problems are as follows: First, the research methods are not innovative enough, and the mainstream methods still adopt the traditional social science research ideas, therefore, it’s still difficult to largely improve the accuracy of the individual psychological analysis of the students; Second, the social attribute of the individual students is ignored, the interaction among individual students is not considered, and the group effect caused by the interaction among students is not given much thought to, either. In order to solve the problems existing in previous studies, this paper proposes a research method based on heuristic swarm intelligence algorithm. Through the comparison with traditional teaching methods, it verified the advantages of the proposed algorithm in physical education.

**ANALYSIS OF THE INFLUENCE OF TRADITIONAL PHYSICAL EDUCATION ON THE SHAPING OF INDIVIDUAL PSYCHOLOGY**

The outline of the physical education objectives requires to strengthen the emphasis on the coordinated development of students’ mind and body. While in traditional physical education, teachers often estimate the students’ individual psychology through interest, ability, character and other aspects with their personal experience, and help them to shape and improve their qualities. Because the teaching skills and accumulated experiences of the PE teachers are uneven, the accuracy of individual psychological estimation of students varies accordingly, so the overall shaping and perfection of students’ individual psychology is not so satisfactory.

Physical education has a certain influence on the psychological factor of interest. Interest enables individual students to fully exert their subjective initiative and learn and achieve their goals with half the effort. Therefore, teachers should attach great importance to the cultivation of students’ interests and help them form positive and correct interest in learning. First, fully respect the individual differences of the students, and give them full autonomy within the framework of the syllabus; the second is to provide students with enough learning materials and guide them to establish a correct learning path and help them eliminate or reduce the difficulties in forming interest in the early stages of learning; the third is to adopt a flexible and vivid teaching style to help students build a correct understanding in a relaxed and pleasant environment; the fourth is to attach importance to teaching reform and to stimulate students to form a more constant interest in learning with more creative teaching methods.

Physical education also has a certain impact on the psychological factor of ability. Ability is a comprehensive presentation of students’ self-confidence and emotional control when they’re solving problems. Therefore, teachers should attach great importance to the cultivation of students' ability, focusing on effectively guiding them in two aspects: self-confidence establishment and emotional control. First, in terms of self-confidence, work with students to break down the sub-goals of each learning stage, and fully respect their individual opinions when reflecting the setting and completion effect of the sub-goals. Second, in terms of emotional control, give full respect and understanding to the students’ ideas and establish an equal negotiating mechanism to conduct positive interactions and help them learn to put themselves in other’s shoes.

Physical education also has a certain impact on the psychological factor of character. Character is an extremely important aspect in the shaping of individual psychology. It often takes the view of things and the way of thinking as the external manifestations. Therefore, teachers should attach great importance to the cultivation of students' character and participate in the character education of students from the following aspects: the first one is the education of speculation, which leads students to "know what it is"; as well as to form the way of thinking of “knowing why it works that way”. The second is to design the education independently, and guide students to form a correct implementation path of “bring up hypothesis boldly
while prove it conscientiously and carefully”. The third is to study the education independently, through demonstration teaching and teacher-student interaction, guide students to develop correct ways of doing things in the process of solving specific difficulties. The fourth is to correct the education actively, through the reflection of education, guide students to establish correct self-control and regulation ability, so as to constantly improve the shaping of their characters.

ANALYSIS OF THE PROMOTION EFFECT OF PHYSICAL EDUCATION TEACHING METHODS ON THE SHAPING OF INDIVIDUAL PSYCHOLOGY BASED ON HEURISTIC SWARM INTELLIGENCE ALGORITHM

Some problems in the social science field are essentially the computational optimization problems of multi-variable functions in high-dimensional space. Due to various limitations such as data collection, model reduction, and computing capacity, social science research often draws less on the latest research results of computational science. So far, only a small number of social science research fields such as demography and management have adopted computational science research methods and have shown good research performance. In this section, this paper attempts to introduce computational science research methods into education, which is also a social science field, in the hopes of improving the teaching methods and further promoting the teaching effect. This section first proposes a new swarm intelligence algorithm, then proposes a new physical education teaching method based on the algorithm, and finally gives an analysis of the promotion effect of the newly proposed teaching method on the shaping of individual psychology.

A new heuristic swarm intelligence algorithm

The swarm intelligence algorithm is an important branch of artificial intelligence research and is often used to solve optimization problems under multi-objective conditions. In the field of social science research, due to the lack of preconditions or the increase of uncertainty, the optimization problem under multi-objective conditions often falls into a local optimum. Therefore, by imitating the mutation behavior of the animal population, the heuristic interference memory is introduced, so that the calculation of optimum could get rid of the local optimum dilemma and the calculation result is approximated to the global optimal solution. Figure 1 shows a schematic diagram of the heuristic swarm intelligence algorithm.

In Figure 1, assume the group \( \{x_1, x_2, x_3\} \) has three individuals, in the process of optimal searching, introduce interference memories \( y_1 \) and \( y_2 \), and finally obtain a group \( \{y_1^*, y_2^*, y_3^*\} \), which approximates the global optimal solution without loss of generality, the optimal solution still uses a general form of mathematical model:

\[
\min f(x)
\]

\[
\text{s.t. } x = (x_1, x_2, \ldots, x_n) \subseteq \mathbb{R}^n
\]  

where, \( f(x) \) represents the objective function to be solved, \( x \) represents an independent vector with a dimension of \( n \), \( \mathbb{R}^n \) represents the \( n \)-dimensional solution space. In addition, with reference to ant colony and bee colony research results, the heuristic interference memory is introduced:

\[
P_\sigma(i) = \left[ \frac{k}{k + \sigma} \right]^{\frac{1}{2}}
\]

\[
P_\omega(i) = \left[ 4\omega - j \right]^{\frac{1}{2}}
\]

Where, Formula (2) is the memorizing probability of the \( i \)-the individual in the group, \( k \) and \( \sigma \) are the input information entropy and memorizing factor.

Figure 1. A schematic diagram of the heuristic swarm intelligence algorithm

![Figure 1. A schematic diagram of the heuristic swarm intelligence algorithm](image-url)
respectively; Formula (3) is the forgetting probability of the $i$-th individual in the group, $\omega$ and $j$ re the output information entropy and forgetting factor, respectively. After clarifying the optimized mathematical model and the interference memory, the implementation steps of the heuristic swarm intelligence algorithm are as follows:

Step 1, initialize the number of individuals in the population, the neighborhood value, and the number of iterations;

Step 2, set the memorizing and forgetting probabilities for each individual in the population;

Step 3, randomly select an individual, update its neighborhood, other individual information, memorizing probability and forgetting probability according to the rule of the population;

Step 4, according to the number of iterations and the optimal calculation result, determine whether to terminate the loop or not.

**A new physical education teaching method based on heuristic swarm intelligence algorithm**

According to the analysis results in Section 1 of this paper, here we use a vector $s$ to represent a single student individual:

$$s = [h.c.p] = [h_1.L.h_k),(c_1.L.c_l),(p_1.L.p_m)]$$

(4)

Where, $h$ represents an interest vector of a single student individual, $h_k$ represents the $k$-th factor in the interest vector; $c$ represents the ability vector of the single student individual, $c_l$ represents the $l$-th factor in the ability vector; $p$ represents the character vector of the single student individual, $p_m$ represents the $m$-th factor in the character vector.

As for the specific meanings of the factors in the interest, ability, and character vectors, they were set according to the recommendations of experts and senior teachers in the field of physical education. After clarifying the representation method of single student individual, based on the content of Section 2.1 of this paper, the specific implementation steps of the physical education teaching method based on the heuristic swarm intelligence algorithm are given below:

Step 1: conduct a questionnaire survey to all students, and construct the initial vector $s$ of single student individual according to the previous achievements and teacher’s comments;

Step 2: use the clustering method and divide the students into several subsets according to the vector space distance, and each subset is regarded as a group;

Step 3: for each individual vector in each group, add the memorizing probability and the forgetting probability to make it a heuristic deformation vector $\%$:

$$\% = [h.c.p_i P_j (i)]$$

(5)

Step 4, carry out targeted teaching on each group, according to the learning result, with each group as a unit, use the swarm intelligence algorithm to conduct synchronous update on the representation vector $%$ of single individual;

Step 5, after all the updates of the students are completed, the clustering method is used again to re-divide the students into several subsets;

Step 6, repeat steps 4 and 5 until the end of the course.

A schematic diagram of the physical education teaching method based on the heuristic swarm intelligence algorithm is shown in Figure 2. It can be seen from Figure 2 that during the whole teaching process, the deformation vector is updated several times, and the division of the subsets is continuously optimized through multiple clustering operations, which provides a better technical support for teachers to carry out targeted teaching.

**Figure 2. Schematic diagram of physical education teaching method based on heuristic swarm intelligence algorithm**
Analysis of the promotion effect of new teaching methods on the shaping of individual psychology

It can be seen from the content of Section 2.2 of this paper that the new teaching method proposed in this paper introduces human factors only in the early stage of the algorithm operation, that is, set the specific meanings of the factors in the interest, ability and character vectors according to the suggestions of experts and teachers. Once the algorithm starts running, it is almost no longer interfered by any human factors, and only the representation vector of single student individual needs to be updated according to the running result of the swarm intelligence algorithm. The advantages of this kind of improvement are quite obvious, the first is that it can reflect the psychological state of individual students to the greatest extent; the second is that it considers the social attributes of people, pays attention to the mutual influence of individual students, and simulates the exchange and interaction to the greatest extent through the swarm intelligence algorithm; the third is that it provides a more accurate reference for the PE teachers to further carry out targeted teaching, which directly affects the final effect of the individual psychological shaping of the students; the fourth is that it re-clusters the students in stages to make the targeted teaching more flexible, which is consistent with the actual teaching practice. In summary, the new teaching method has a significant role in promoting the shaping of individual psychology. In the next section, the promotion effect will be analyzed quantitatively through experimental data.

EXPERIMENTAL RESULTS

This section contains three parts: research object selection, questionnaire design, and comparison of old and new methods.

Research object selection

A total of 213 sports-major students were selected from a normal college (recorded as Group A), and then divided into two similar groups A1 and A2, which included 107 and 106 students, respectively. In addition, 198 non-sports major students from a comprehensive university (recorded as Group B) were selected and divided into two groups, B1 and B2, which included 101 and 97 students, respectively. The composition of the research objects is shown in Table 1.

| College category | Major category | Group name | Student number |
|------------------|----------------|------------|----------------|
| Normal college   | Sports major   | A1         | 107            |
|                  | Non-sports major | A2          | 106            |
| Comprehensive university | Non-sports major | B1          | 101            |
|                  |                | B2          | 97             |

The A1 and B1 groups shown in Table 1 were taught by the original traditional teaching method, and the A2 and B2 groups were taught by the new teaching method proposed in this paper. Through the comparison of the learning effects of the four groups of students, the promotion effect of the proposed method on the shaping of individual psychology was studied.

Questionnaire design

This paper referred to the general psychology SCL-90 scale and the Eysenck Personality Questionnaire (EPQ) to produce questionnaires which were filled freely by the subjects. Before the questionnaires were filled out, clear instructional terms were used to inform the subjects about the filing rules, submit time limit, and matters need attention. A total of 411 questionnaires were distributed and 405 questionnaires were returned, including 3 invalid questionnaires. Data cleaning was performed on 402 valid questionnaires, according to the mean value of the quantified data after data cleaning, for 9 questionnaires with missing data, the data filling technology of data mining was adopted to complete the data in these questionnaires. The representation vector of single student individual was set according to the recommendations of experts and senior teachers in the field of physical education, as shown in Table 2.

The interest vector shown in Table 2 consists of four vector factors, namely, the willingness to learn actively, the willingness to cooperation actively, the persistent level of incentives, and the exchange and interaction level; the ability vector consists of three vector factors: manifestation of self-confidence, manifestation of learning strategy, and the emotion control ability; the character vector consists of three vector factors, respectively are: manifestation of willpower, manifestation of research consciousness, and the self-reflection level. The last column of Table 2 is the distribution of the initial weights of the factors.
Table 2. Setting of representation vectors of single student individual

| Vector category | Vector representation | Vector composition | Meaning of each factor | Initial weight of each factor |
|-----------------|-----------------------|--------------------|-----------------------|-----------------------------|
| Interest factor | $h_1$                 | Willingness to learn actively | 0.10                 |
|                 | $h_2$                 | Willingness to cooperate actively | 0.05                 |
|                 | $h_3$                 | Persistent level of incentives | 0.12                 |
|                 | $h_4$                 | Exchange and interaction level | 0.06                 |
| Ability factor  | $c_1$                 | Manifestation of self-confidence | 0.07                 |
|                 | $c_2$                 | Manifestation of learning strategy | 0.13                 |
|                 | $c_3$                 | Emotion control ability | 0.11                 |
| Character factor| $p_1$                 | Manifestation of research consciousness | 0.09                 |
|                 | $p_2$                 | Self-reflection level | 0.14                 |

Table 3. Comparison of individual psychology shaping of students in groups A 1 and A2 at two time-nodes in group A

| Time node       | Group name | Teaching method           | Comprehensive score of individual psychology (out of 100) |
|-----------------|------------|---------------------------|----------------------------------------------------------|
| Semester end    | A1         | Traditional teaching method | 62                                                       |
|                 | A2         | Proposed teaching method  | 79                                                       |
| School year end | A1         | Traditional teaching method | 65                                                       |
|                 | A2         | Proposed teaching method  | 91                                                       |

Table 4. Comparison of individual psychology shaping of students in groups B1 and B2 at two time points in group B

| Time node       | Group name | Teaching method           | Comprehensive score of individual psychology (out of 100) |
|-----------------|------------|---------------------------|----------------------------------------------------------|
| Semester end    | B1         | Traditional teaching method | 66                                                       |
|                 | B2         | Proposed teaching method  | 72                                                       |
| School year end | B1         | Traditional teaching method | 68                                                       |
|                 | B2         | Proposed teaching method  | 95                                                       |

Comparison of old and new methods

The end of a semester, and the end of a school year were taken as two time-nodes of the comparison of the new and the old methods. The individual psychology shaping results of students in groups A and B were compared, and the comparison results are shown in Tables 3 and 4.

It can be seen from Table 3 that for the sports major students of the normal college, in the comparison of the effects of the two teaching methods at the end of the semester, the student groups taught by the proposed teaching method had an individual psychology comprehensive score of 79 points, which is higher than that of the student groups taught by the traditional teaching method, whose score was 62 points. Moreover, in the comparison of the effects of the two teaching methods conducted at the end of the school year, the gap between the scores became more obvious (respectively were 91 points and 65 points).

It can be seen from Table 4 that, for the comprehensive university non-sports major students, the same score trend was also shown in the comparison of the effects of the two teaching methods at the end of the semester and at the end of the school year. This indicates that for different groups of students, the methods proposed in this paper can better assist them in shaping and perfecting their psychology.

CONCLUSION

This paper proposed a research method for individual psychology shaping of physical education based on heuristic swarm intelligence algorithm. It used the swarm intelligence algorithm in the field of artificial intelligence to give more accurate evaluations to students’ psychological factors from aspects of interest, ability and character, hereby shaping their individual psychology in a more targeted manner. Our innovation mainly has two aspects: one is that it introduced more mature technologies in the field of artificial intelligence to the social science research and conducted quantitatively analysis and research on the teaching effects of physical education; the second is that it gave respect to the social attribute of student individuals and paid attention to the mutual effect of different factors.
influencing effect among students, and accurately carried out teaching effect evaluation through the swarm intelligence algorithm. The experimental results show that the proposed algorithm is helpful to the shaping of individual psychology in college physical education, and it also shows a good teaching effect. The next research direction is mainly to expand the factor dimension in the individual representation vector, in the hopes of further improving the stability of the proposed algorithm in the practice of physical education.

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