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Evaluation and analysis of effectiveness and training process quality based on an interpretable optimization algorithm: The case study of teaching and learning plan in taekwondo sport

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ABSTRACT

Taekwondo is a martial art emphasizing defense, protection, and moral and spiritual values. Evaluating the effectiveness and quality of Taekwondo sports training is a complex task that requires the consideration of various factors, such as the learners' skills, physical condition, and psychological state. Traditional methods for evaluating sports training effectiveness and quality have limitations, such as being subjective, time-consuming, and not considering individual differences. This paper proposes a new approach to evaluating the effectiveness and quality of Taekwondo sports training using optimization algorithms. Specifically, three optimization algorithms, TLBO, DSLTLBO, and GWO, are compared and analyzed for their suitability at different levels. These algorithms can automatically adjust the sports training plan based on individual differences and learner feedback, which can address the limitations of traditional evaluation methods. Validity statistics and moral/spiritual level assessment are used to evaluate the training results and process quality. The results indicate that different optimization algorithms are appropriate for learners at different levels. Diversified algorithm forms are recommended for a comprehensive evaluation of the sports plan. This paper provides insights into optimizing Taekwondo sports training and highlights the importance of cultivating moral and spiritual values through this martial art. The proposed approach can potentially improve the effectiveness and quality of Taekwondo sports training and can be extended to other sports or physical activities.

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Introduction

What is Taekwondo? First of all, taekwondo is one of the most important sports activities for human beings. It is a part of people's thinking, breathing and action, and also a part of human life. It is also a protective behavior to

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cultivate healthy personality and related self-defense techniques (Rebelo et al. 2021). Therefore, taekwondo can be defined as a meaningful lifestyle and sport for some people (Kudinova et al. 2021).

Secondly, taekwondo is also a martial art. In most cases, martial arts represents a spirit and feelings, not just self-defense or daily one-sided "fighting." Taekwondo is a martial arts behavior that can easily dissolve the enemy's attack without using any weapons in the game (Markel et al. 2020). Self-defense is important and necessary for both boys and girls in modern society. Taekwondo is a method and technique of self-defense of all body parts through training and intense mental stimulation in the face of enemy attacks (Allison, Fernandez Claire, and Terry Michael 2020). In ancient times, taekwondo can be understood as "martial arts" in martial arts novels, while in modern times, it can be understood as "kung fu" or "modern martial arts."

In previous studies, there are few studies on taekwondo, even if there are relevant studies, they are based on theoretical research. For example studies scholars put forward in all sorts of problems existing in the college teaching taekwondo, the author firstly emphasizes the tae kwon do in colleges under the multiple significance, secondly puts forward some problems in colleges and universities to carry out the taekwondo training, such as training goal is not clear in the taekwondo training, many problems appeared in the process of training in class and extracurricular activities is unitary and so on. Finally, the author puts forward some strategies to solve the above problems, among which the evaluation system in taekwondo training should be improved (Lorås 2020). Therefore, for the taekwondo and traditional sports, taekwondo has a certain "fresh," should be fully reflected in the process of sports training in text, give full play to different students teaching properties of diversified characteristics, and, more importantly, in the process of motion planning, not only to consider the students' ability to accept. In addition, teaching objectives can be more clearly defined and the richness of after-class teaching content can be enriched, so that Taekwondo can further develop and grow in different fields (Matti et al. 2020).

Optimization algorithms are computer-based methods for finding the optimal solution to a problem. In sports training, optimization algorithms can be used to design and optimize training plans tailored to individual learners' needs and characteristics.

Traditional methods for evaluating sports training effectiveness and quality often rely on subjective judgments from trainers or coaches or pre-designed training plans that do not consider individual differences in skills, physical condition, or psychological state. These limitations can lead to a suboptimal training program that does not fully realize the learners' potential.

Optimization algorithms, on the other hand, can automatically adjust the training plan based on learner feedback, such as their performance and preferences, and optimize the plan to achieve the desired training goals. For

example, an optimization algorithm can adjust the intensity and frequency of the training sessions based on the learners' physical condition or modify the training exercises based on the learners' skill level.

By comparing and analyzing different optimization algorithms, the paper identifies the most suitable algorithm for learners at different proficiency levels. For instance, the TLBO algorithm may be more appropriate for learners at a medium level, while the DSLTLBO algorithm may be more suitable for learners at a higher level. This can provide valuable insights into optimizing Taekwondo sports training and help instructors and trainers design more effective and efficient training programs. Overall, optimizing algorithms can lead to a more personalized and effective training program that maximizes the learners' potential and achieves the desired training goals.

In combination with the theoretical research content, this paper puts forward the use of teaching and learning optimization algorithm in the process of taekwondo sports training for a certain evaluation, and then provides a certain reference significance and application value for taekwondo in the training and teaching process.

Research Background

From the first section, it is clear that Taekwondo can be considered as a sport within a sport, which not only improves the physical quality of the practitioner, but also provides a certain spiritual inculcation. With the rapid development of our economy and culture, our education philosophy has gradually moved from the level of "exam-oriented education" to the direction of quality education, and because of the influence of our quality education philosophy, both in rural and urban areas have gradually paid attention to the physical education of students. In schools, the aim is not only to train a group of "examination machines," but also to train well-rounded students who are good at knowledge and theory as well as physical fitness (Kathleen et al. 2020). Therefore, many universities are now strengthening the requirements of physical education classes and greatly enriching the teaching content, and taekwondo is one of the most popular sports among students and teachers (Michael and David). Among them, a survey was conducted to investigate the feedback of students and teachers about the activity of taekwondo in colleges and universities, as shown in Figure 1 below.

As shown in Figure 1, according to the results of the survey, the number of people surveyed was 60 teachers and 60 students. The results show that taekwondo in schools has the support of a large number of students and teachers. Among the teachers, 4 of them said that they could not accept taekwondo in schools because most of the teaching of taekwondo is at a low level and it is not helpful to the students and it is a waste of time. In the surveyed group of students, only two out of 60 people could not accept

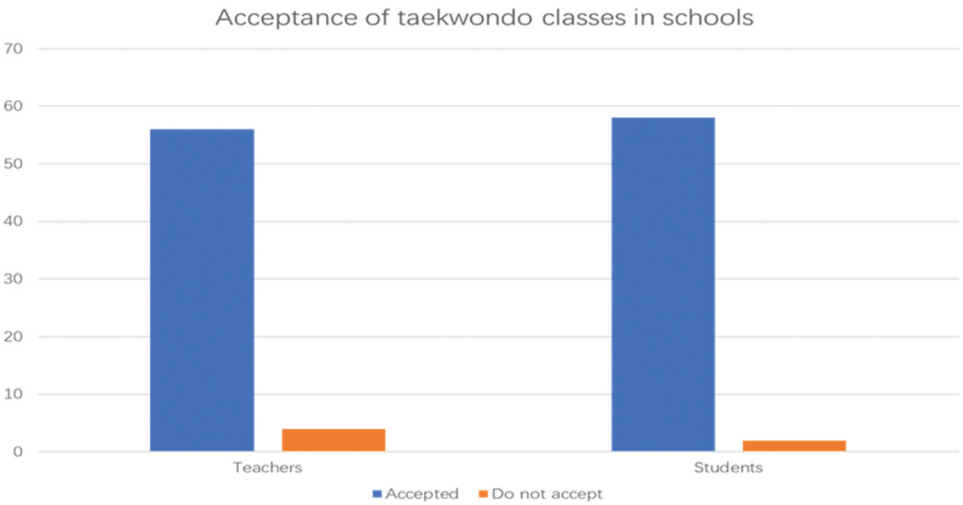

Figure 1. Based on teachers' and students' acceptance of taekwondo in schools.

the teaching of taekwondo in school because they should study well in school and should not spend too much time on matters not related to their studies, and also because they think that taekwondo is a sport that consumes too much physical energy during training and their bodies cannot bear it, etc.

In summary, taekwondo as a sport introduced into schools is acceptable to the majority of people, there are many reasons for not accepting it, and the most essential problem is the lack of proper knowledge and in-depth understanding of taekwondo among the non-accepting groups, so it is necessary to popularize taekwondo publicity and general knowledge promotion (Michael and David). In order to analyze in depth the effectiveness of the exercise program and the quality of the process in taekwondo sports training, this paper starts with the problems that exist in taekwondo sports training.

Problems of Taekwondo in Sports Training

1) the Role of Taekwondo for College Students is Not Understood Comprehensively and Deeply Enough

As can be seen from the previous statement, many of the major problems in the analysis of the reasons for the non-acceptance of the different groups in the survey results in Figure 1 lie in the fact that the reason why taekwondo is not accepted in schools is that they do not know what taekwondo is and what the role of this sport is (García-Hermoso et al. 2020). Therefore, if it is hoped that taekwondo will be vigorously promoted, it is important to increase the popularity of the basics of taekwondo so that people understand what taekwondo is and why they want it to be taught in schools, and more importantly,

understand the benefits and significance of taekwondo for students in all aspects of their development (Trail and McCullough).

2) Inadequacy of Teachers in Taekwondo Curriculum

It has been close to 10 years since quality education was promoted in China, and sports are no longer just for show. More and more different types of sports are sprouting up like a spring rain (Hurst, Ring, and Kavussanu 2020). Taekwondo is one of them. However, because taekwondo is "new" and "new," there is a lack of professionalism in the training of taekwondo as a sport in China, and there is a phenomenon of taekwondo teachers having several jobs (Giusti et al. 2020). Behind this phenomenon is a reflection of the fact that the teachers of taekwondo in China are not strong enough, and that they do not have enough time to concentrate on the teaching and learning of taekwondo because of their heavy workload. Therefore, even if the corresponding taekwondo teaching is carried out in the society or in schools, due to the limited ability of teachers, students are not able to effectively strengthen their own training effect in the learning process, moreover, they lack a certain reference, and have no way to see which level they really reach (Véronique, Laberge, and Suzanne 2020).

3) the Lack of Attention to Theoretical Knowledge of Taekwondo in Teaching

Taekwondo is an athletic course, so many teachers only pay attention to the teaching of body techniques in class and ignore the importance of theoretical knowledge. It is very difficult for students to understand taekwondo in a real sense without integrating it with theory, let alone understanding the history of taekwondo and the corresponding movement techniques (Marcelo et al. 2020). In the process of teaching, the lack of theoretical knowledge transmission leads to a lack of love for taekwondo in the learning process, which essentially means a lack of cultivation of the martial arts spirit, and thus the students turn from a "passing fancy" to an avoidance mentality. Because of the difficulty of trying to learn taekwondo, which is more profound than the feeling of success, students are left with only confusion and fear for the rest of their lives, and thus the problem of difficulty in increasing their motivation (Tibebu et al. 2020). All of these problems are caused by the teachers' lack of in-depth teaching of theoretical knowledge in the teaching and learning process (Helmi et al. 2020).

Evaluation of the Effectiveness and Quality of Taekwondo in Sports Training

Taekwondo is a sport that not only promotes the physical fitness of students, but also enhances their spirituality and is a competitive sport, so in the process of teaching and learning Taekwondo, it is necessary to assess not only the effectiveness but also the quality of Taekwondo in sports training (Alex et al.

2019). The assessment of effectiveness is based on the results of taekwondo training, while the assessment of quality takes into account not only the skills and methods of taekwondo training, but also the moral and spiritual development of the students.

Taekwondo contributes to the improvement of physical fitness in the process of sports training.

Taekwondo originated in North Korea and was introduced to China in the 1990s, and now it is one of the important sports in the Olympic Games (Olaf et al.). And taekwondo is characterized by stance, speed, and strength. In order to achieve a better demonstration of strength and effect, students need to do a lot of training in the process of sports training, and through these training constantly improve the students' cardiorespiratory function, and consume excessive body fat, and through the combination with the diet, and eventually the fat can be converted into muscle to the maximum extent. Therefore, taekwondo is not only good for improving students' physical fitness in the process of sports training, but also enables them to build a good body shape that can greatly reflect strength and beauty. In this paper, a system of taekwondo is explored for use in the teaching and learning process of taekwondo by evaluating the skills, methods and speed of the trainees.

Taekwondo facilitates the spiritual aspect in the process of sports training.

Taekwondo is not only a competitive sport, but also a sport related to spirituality (Emerson, Takito Monica, and Takito 2019). The characteristics of taekwondo can be integrated with the Eastern national culture, which is also complementary. More importantly, Taekwondo originated in North Korea, which is a neighboring country of China, and the culture has been integrated to a certain extent over the years, while Taekwondo contains cultural characteristics such as unity and mutual help, which are consistent with the Taoist and Confucian cultures of China. Taekwondo does not only pursue skills and techniques in sports training, but also the spiritual pursuit and the hard training to become a qualified Taekwondo person. Therefore, taekwondo can help learners improve their spiritual pursuit during athletic training and exercise their willpower, eventually forming a resilient character with a beginning, end, and stoicism. In this paper, the moral and theoretical aspects of the trainees will be considered in order to assess the need for quality in the process of taekwondo training.

Materials and Methods

Teaching-Learning Optimization Algorithm

The Teaching-Learning Optimization algorithm, abbreviated as TLBO algorithm, was proposed by RAO et al. in 2011 as an algorithm for local optimization of groups.

Compared with other swarm intelligence algorithms, its biggest advantage is that it does not require specific parameters of the algorithm to run. This approach is able to mimic to a large extent the process of teaching and learning in the traditional sense of the classroom. The meaning of "teaching and learning" represents the two phases of teacher instruction and student learning, respectively. In the student learning phase, each student in the set learns from individuals in the same set in a randomized manner, and each learner learns from each other through interaction; in the teacher teaching phase, each student learns from the best individual, which generally means that the student learns from the teacher.

In TLBO, the concept of population is used, i.e., the population will be considered as heterogeneous learners. And each learner may have the optimal solution to a certain problem. In the algorithm, the teacher-student and student-student interactions and the score system, which is the same as in traditional courses, are used to determine excellence and non-excellence, i.e., the score represents the fitness value in the algorithm. The teacher is generally considered as the learner with the optimal solution in the algorithm.

In the teacher-taught phase, the teacher T is the solution with the optimal solution in the population of the algorithm, i.e., the teacher T has the best fitness value, for the ith learner XI, where the formula for the candidate solution NEWXI is shown in (1.1) as follows.

$$NEWXI = XI + rand^{*}(T - Tf^{*}M) \tag{1.1}$$

Where in Eq. (1.1), XI represents the level of knowledge of the ith learner before experiencing the teacher-taught stage, and NEWXI represents the level of knowledge of the ith learner after experiencing the teacher-taught stage. And T represents the teacher, M is the average grade of the whole population (class), rand is a random function in the algorithm that represents all random numbers between [0,1], and Tf is the instructional factor that determines the average grade of the class M, where Tf is calculated as shown in Eq. (1.2) below.

$$Tf = round[1 + rand(0, 1)] \tag{1.2}$$

From Eq. (1.2) and Eq. (1.2), it is clear that the generation of new candidate solutions is inextricably linked to class average performance.

After going through the instructor-led phase, the algorithm then reaches the student learning phase. In this phase, each learner needs to improve his/her performance by interacting with randomly selected learners in the classroom as a reference. The formula for this is shown in (1.3).

$$NEWXI = \begin{cases} XI + ri^{*}(XI - XJ), f(XI) < f(XJ) \\ XI + ri^{*}(XJ - XI), otherwise \end{cases} \tag{1.3}$$

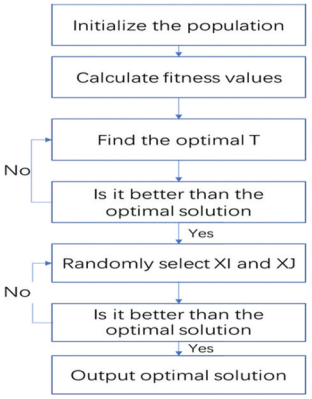

Figure 2. The basic flow of the teaching-learning optimization algorithm.

where in Eq. (1.3), the values of I and J are chosen randomly in the population, ri represents the rand function, and f denotes the objective function to be optimized. Where f(XI) represents the adaptive value of the Ith student, and f(XJ) represents the adaptive value of the Jth student. If f(XI) < f(XJ) when both I and J are selected, the new candidate will be calculated by the upper half of the formula, otherwise the lower half of the formula will be adopted.This way of deciding to update the candidate solution by comparing two different objective functions can guarantee the correctness of the algorithm to a large extent.

Among them, the basic steps of the algorithm regarding teaching-learning optimization can be as follows. As shown in Figure 2.

As can be seen from Figure 2, the basic process of the teaching-learning based optimization algorithm can be divided into two stages, one for the teacher and the other for the student. The teacher stage starts from determining the optimal solution T to determining the optimal solution by comparison, and for the student stage, it starts from comparing XI and XJ to determining the optimal solution for the student stage. In the teaching-learning optimization algorithm, the first step is to initialize the group of learners and determine the criteria for termination of the algorithm, and then to determine the class average and obtain the optimal solution T. Then, the teacher stage is entered, in which the NEWXI of the learners is calculated by Eq. (1.1), and if the NEWXI is better than the previous XI, then the XI needs to be updated. Otherwise, the calculation is reselected. After the teacher stage, the algorithm will select a random I and J in the population and calculate the NEWXI by using Eq. (1.3), if XI is better than XJ, then the upper part of Eq. (1.3) will be selected for calculation, if XI is inferior to XJ, then the lower part of Eq. (1.3) will be selected for calculation, and finally the final result will be obtained by comparing The final result is compared with the termination criterion determined in step 1, and if the final result satisfies the termination criterion, then the optimal solution is obtained.

Analysis of the Relationship Between Adaptive and Teaching-Learning Optimization Algorithms

What is "adaptive"? First of all, adaptive refers to the ability of a transaction to automatically adapt to changes in a law or rule. Furthermore, in general, adaptive refers to the process of processing and analyzing some transactions or data in a certain scenario, and in the process, it is able to automatically adjust the processing methods, or the order, parameters, and constraints of some processing by the characteristics of the data or transactions obtained. Thus, adaptive processing allows the pre-processed data or transactions to be dynamically processed in a better way, and in the process, to approach the target.

The adaptive teaching-learning optimization algorithm is an optimization algorithm that adopts adaptive processing, which can turn the teacher and student stages in the teaching-learning optimization algorithm from the original "passive" to "active," and can follow certain rules or directions The final optimization result is optimal. Therefore, it is necessary for the teaching-learning optimization algorithm to be adaptive.

Gray Wolf Optimization Algorithm

Grey wolf optimization algorithm (GWO) is a group intelligence optimization algorithm inspired by the predatory behavior of the gray wolf pack, which has four hierarchies, αβδ and w, and the power is ranked from the largest to the smallest to simulate the leadership of human beings.

As can be seen from Figure 3, the basic steps of gray wolf optimization algorithm can be divided into the following: firstly, tracking and surrounding the prey, secondly, hunting the prey, and lastly, attacking

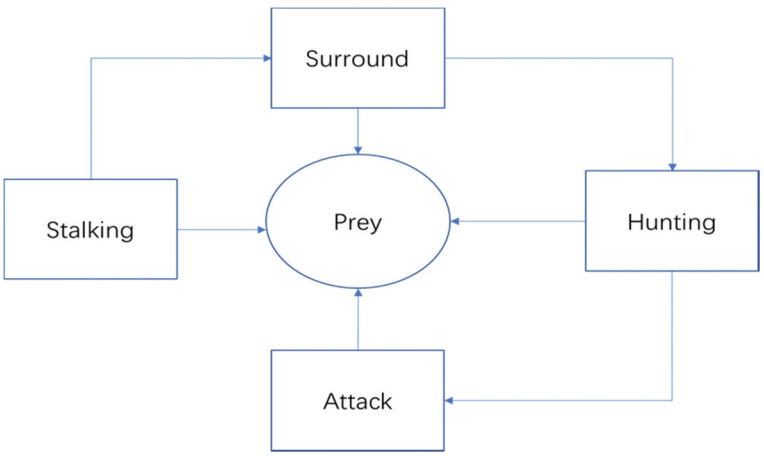

Figure 3. Basic steps of the optimization algorithm of gray wolf.

the prey. Before the first step of tracking and encircling prey, the first step is to construct a social hierarchy model adapted to the gray wolf population, which can then be used to realize the mathematical modeling of the gray wolf population. In the gray wolf optimization algorithm, a large search space can be considered first, and the prey trail is the target that the gray wolf group needs to find in this search space, although it is difficult to do this in the computational simulation, because in reality the gray wolf can rely on smell, eyes, etc. to sense the specific location of the prey, but the gray wolf algorithm can be used to roughly describe the process of the gray wolf group to find the prey. The process of finding the prey can be roughly described using the gray wolf algorithm.

In the gray wolf optimization algorithm, it is assumed that the location of the prey is provided by the best solution found in a large search space artificially, and the algorithm is expressed in the process of searching for the prey by the gray wolves through the iterative process of the algorithm, and then the best solution can be solved or obtained continuously. And because the position of the prey is only expressed as optimal at the initial position, because the prey is free to move, this also symbolizes the relationship between the best solution and the candidate solution for teaching and learning optimization. However, in the gray wolf optimization algorithm, α is first set as the optimal solution, which means that the fitness of the individual in the teaching and learning optimization algorithm is optimal, while β is the suboptimal solution, but the optimal solution in the gray wolf optimization algorithm is δ, while w represents the candidate solution. In the process of gray wolf hunting, it is guided by αβδ together, while w denotes the other wolves that follow these three leadership classes, so it is always possible to find these three parameters or the best solution in this algorithm, and then use these three parameters to form a search space and search in this region, with the final purpose of finding a better solution subsequently to update the αβδ parameters. One of the formulas for gray wolf location update is shown in (1.4).

$$X(\mathrm{t}+1 = X_{\mathrm{p}}(t) - A \cdot D \tag{1.4}$$

After the above discussion, it is clear that for the gray wolf optimization algorithm, it is essentially the same as the teach-and-learn optimization algorithm, which is to determine the optimal solution among the candidate solutions. Therefore, this paper will compare the effectiveness and process quality of the exercise plan in taekwondo sports training by using the traditional teaching-learning optimization algorithm and the gray wolf optimization algorithm. The evaluation of the quality of exercise planning and process in taekwondo sports training is carried out by comparing the Grey Wolf optimization algorithm with its TLBO and DSLTLBO algorithms.

Results and Discussion

In Section 3, the traditional teaching-learning optimization algorithm and the gray wolf optimization algorithm are discussed, and the relationship between the adaptive and the teaching-learning optimization algorithm is identified, and it is concluded that the teaching-learning optimization algorithm with adaptive features is very helpful for the process evaluation of the effectiveness and quality of the exercise plan in taekwondo sports training. Therefore, in this paper, in order to demonstrate the feasibility and comparability of the evaluation of the effectiveness and quality of the sport of taekwondo in sports training, the three algorithms will be compared and evaluated in the process of teaching taekwondo, and the best results will be obtained in order to provide some value and meaning to the subsequent research on taekwondo.

In Section 2, it is suggested that the "effectiveness" of this study is based on the results of the learners' training, while the "quality" is based not only on the results of the learners' training, but also on the moral and spiritual aspects of taekwondo. In order to study whether the T&L optimization algorithm can accurately evaluate the effectiveness and quality of taekwondo learners in the sport training process, this paper selects the T&L optimization algorithm and the Gray Wolf optimization algorithm for a comparative study. In this paper, two types of teaching-learning optimization algorithms are adopted, one is the traditional teaching-learning optimization algorithm described in Section 3.1, and the other is the adaptive teaching-learning optimization algorithm, the basic block diagram of which is shown in Figure 4.

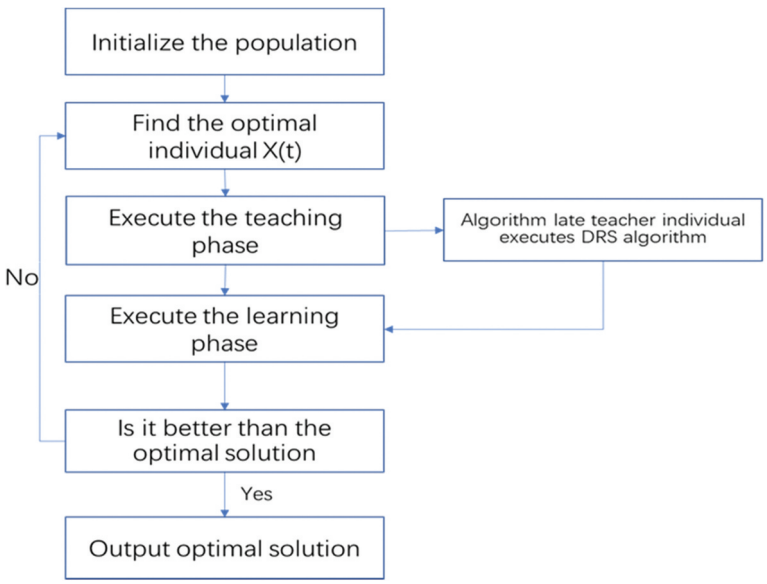

Figure 4. Basic steps for introducing an adaptive teaching-learning optimization algorithm.

In this paper, the effectiveness of the taekwondo sports training program is compared using the average convergence curve of the algorithm, and the quality of the program is evaluated in the form of final results, both online and offline. The TLBO algorithm and the DSLTLBO algorithm will be used to compare the effectiveness of the algorithm using the average convergence curve. The adaptive values of the TLBO, DSLTLBO and GWO algorithms are shown in Figure 5.

In Figure 5, the dimensions used in all three algorithms are 60 dimensions, and both Figures 5 and 6 represent the average convergence curves of the adaptive degree values of the three different algorithms. Observing Figure 5, it can be seen that the blue curve in the Figure is the TLBO algorithm, which represents the traditional teaching and learning optimization algorithm, the orange curve represents the DSLTLBO algorithm, which represents the teaching and learning optimization algorithm with the introduction of adaptivity, and the gray curve represents the GWO algorithm, which represents the Gray Wolf optimization algorithm. Comparing the convergence changes of the three different algorithms in 60 dimensions, it can be seen that the convergence performance of the DSLTLBO algorithm with the introduction of the adaptive feature is better and the convergence time is shorter for the TLBO algorithm and the DSLTLBO algorithm, but the curve of the TLBO algorithm is smoother in terms of smoothness. The convergence performance of the TLBO algorithm is better than that of the GWO algorithm, and the convergence process of the TLBO algorithm requires fewer iterations than that of the

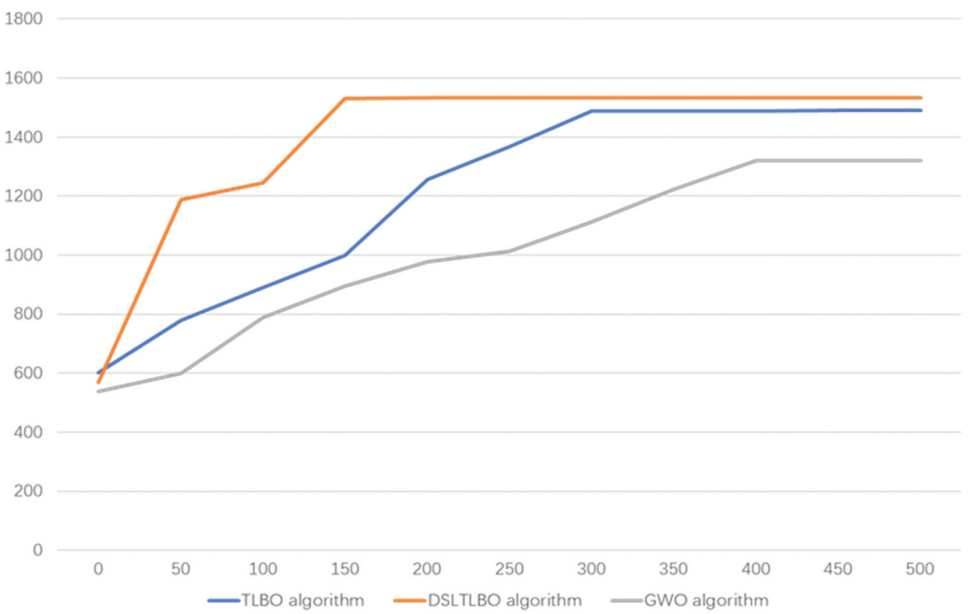

Figure 5. Comparison of the adaptivity values of TLBO, DSLTLBO and GWO algorithms in 60 dimensions.

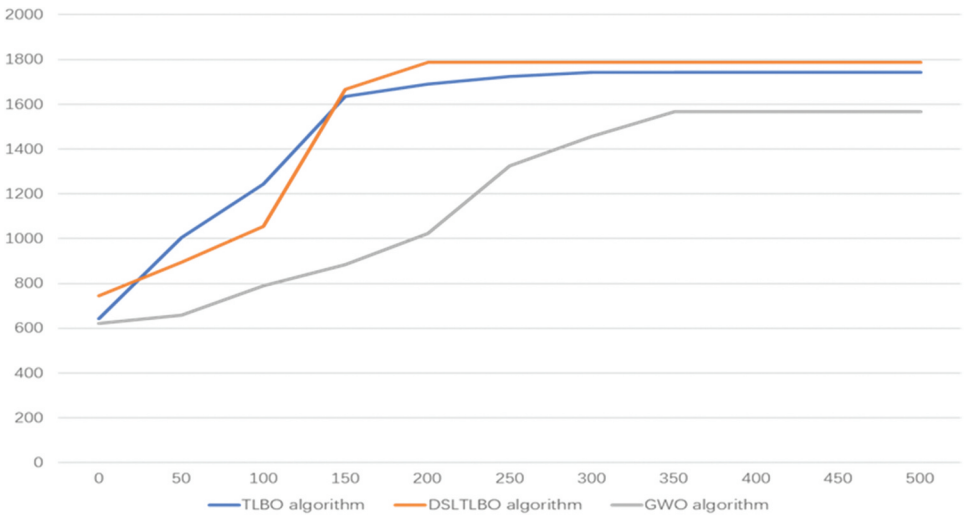

Figure 6. Comparison of the adaptivity values of TLBO, DSLTLBO and GWO algorithms in 80 dimensions.

GWO algorithm, takes less time to reach the equilibrium adaptive degree value, and the curve is smoother.

In order to compare the TLBO algorithm, DSLTLBO algorithm and GWO algorithm more different, so different dimensions are set in these three algorithms for the comparison of algorithm effect. Among them, the average convergence curves of the adaptivity values of the three different algorithms in 80 dimensions are shown in Figure 6 as follows.

Figure 6 shows the comparison of the adaptivity values of the above three algorithms in 80 dimensions. Comparing Figures 5 and 6, it can be seen that the adaptivity value of Figure 6 is larger than that of Figure 5, which is due to the increase in the choice of dimensionality, i.e., the dimensionality has increased from 60 to 80 dimensions. In Figure 6, comparing the DSLTLBO algorithm with the TLBO algorithm, it is found that the DSLTLBO algorithm reaches the smooth adaptivity value earlier than the TLBO algorithm, i.e., less iterations are needed during the algorithm operation; comparing the TLBO algorithm with the GWO algorithm, it is found that the number of iterations of the TLBO algorithm is less than that of the GWO algorithm, proving that the TLBO algorithm The TLBO algorithm takes less time than the GWO algorithm to find the best adaptive degree value, and has a better performance in evaluating the effectiveness and quality of the exercise program in the taekwondo sports training. Also comparing Figures 5 and 6, it is observed that as the dimensionality increases, the three algorithms take less iterations to reach a stable average adaptive degree value, i.e. it takes less time, but the smoothness of the curve during the iterations is rougher in Figure 6 compared to Figure 5. Therefore, when using the different algorithms applied to the

evaluation of the effectiveness and quality of the exercise program in taekwondo sports training in this paper, the appropriate dimension should be chosen according to the different situations. Therefore, it is recommended to use the DSLTLBO algorithm to complete the evaluation of the effectiveness and process quality of the exercise program in taekwondo sports training.

In order to complete the evaluation analysis of the effectiveness and process quality of exercise planning in taekwondo sports training, this paper combines the above mentioned DLSTLBO algorithm and GWO algorithm with the teaching plan and teaching content of taekwondo sports, etc., and finally assesses the classes that have taken different algorithms by means of final examinations, and Figure 7 shows the comparison of final results. As shown in Figure 7.

In Figure 7, where the total number of students in Class 1 and Class 2 is 65, the exercise program developed in Class 1 for taekwondo as a sport is combined with the DSLTOBL algorithm, and the exercise program developed in Class 2 for taekwondo as a sport is combined with the TLBO algorithm. Observing the final results compiled in Figure 7, it can be seen that the number of students in Class 1 is higher than that in Class 2 in both the excellent interval as well as the passing interval, indicating that the program developed under the DSLTOBL algorithm for taekwondo sports training has been improved for higher level learners and lower level learning; while in the good interval, the number of students in Class 2 is higher than that in Class 1, indicating that the TLBO algorithm is more suitable for lower In the failing

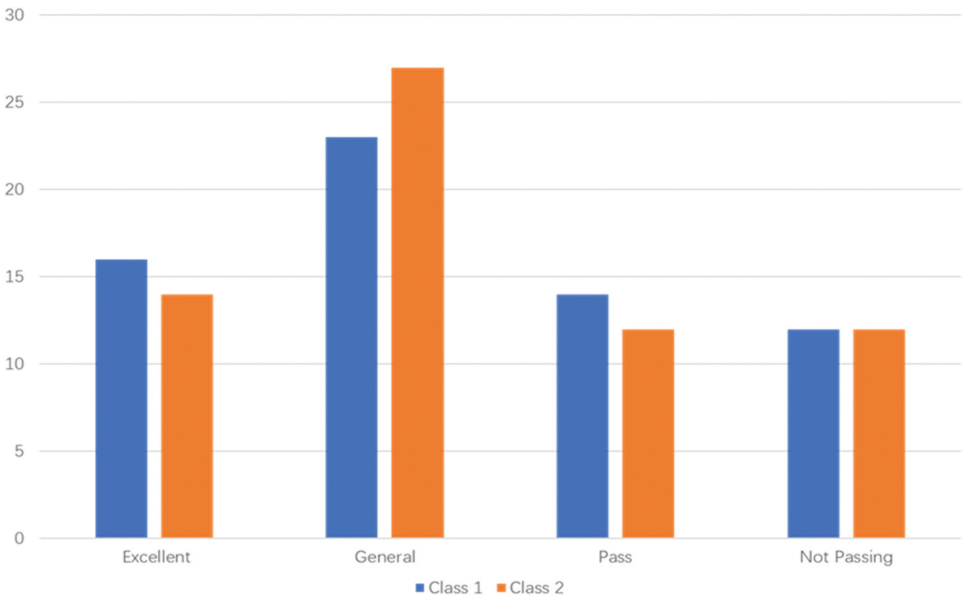

Figure 7. Comparison of class performance for exercise programs developed under different optimization algorithms.

interval, the numbers are basically the same for both the DSLTLBO algorithm and the TLBO algorithm, indicating that the usefulness of both algorithms for very poor learners needs to be improved.

In order to better reflect the effectiveness and qualitative efficacy of the teaching-learning optimization algorithm in the exercise program of taekwondo sports training, a subjective questionnaire was administered to all students in the same class 1 and class 2 after the final examination, as shown in Figure 8.

Figure 8 shows the class satisfaction survey under different optimization algorithms. Class 1 represents the class with the taekwondo sports training exercise plan developed under the DSLTLBO algorithm, and class 2 represents the class with the taekwondo sports training exercise plan developed under the TLBO algorithm. Observing the data in the Figure shows that for the DSLTLBO algorithm, the number of satisfied is significantly higher than the number of class 2 under the TLBO algorithm, and the number of dissatisfied is also lower than the number of TLBO algorithm, indicating that for taekwondo learners there is a general usefulness and higher acceptance among both high and low level groups, and this is also reflected in the final results in Figure 7 This is also reflected in the final grades in Figure 7. The fact that the number of students in Class 1 is less than that in Class 2 indicates that the TLBO algorithm is more suitable and accepted by the intermediate level group than the DSLTLBO algorithm. Therefore, different teaching and learning optimization algorithms can be used for different levels of learners in taekwondo sports training to maximize the quality and effectiveness of the teaching process.

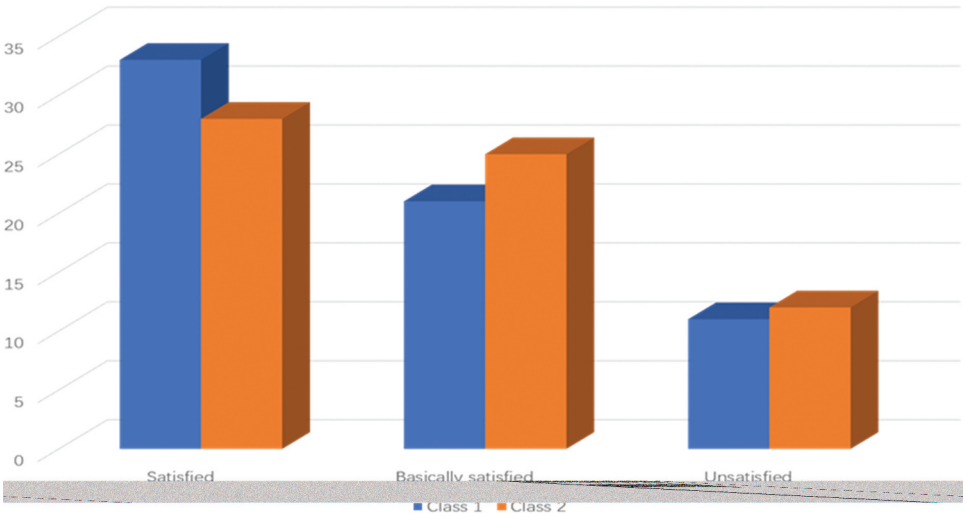

Figure 8. Class satisfaction survey under different optimization algorithms.

It is possible to use non-heuristic methods to resolve the problem of evaluating the effectiveness and quality of Taekwondo sports training. Non-heuristic methods, such as statistical analysis, can be used to evaluate the training results and quality of the process based on empirical data.

However, it is important to note that non-heuristic methods may have some limitations compared to heuristic methods, such as being less adaptable to individual differences and feedback from learners. Heuristic methods, such as the optimization algorithms used in the study, can automatically adjust the sports training plan based on individual differences and feedback, which can lead to a more personalized and effective training program.

Therefore, the choice of method depends on the specific research question and objectives, as well as the availability of data and resources. Heuristic methods may be more appropriate for certain problems that require adaptability and optimization, while non-heuristic methods may be more appropriate for other problems that require statistical inference and hypothesis testing.

Overall, both heuristic and non-heuristic methods can be used to resolve the problem of evaluating the effectiveness and quality of Taekwondo sports training. The choice of method depends on the specific research question and objectives.

Conclusion

Taekwondo literally means "punching," "hitting," "kicking," and "kicking." The "kick" in Taekwondo is the "punch," "punch," "kick" and "kick." In Taekwondo, "punch" means self-defense under certain circumstances, while "do" means moral cultivation. Therefore, the sport of Taekwondo must undergo continuous scientific training in order to keep the body and mind in a healthy state, so that the muscles of the whole body can be mobilized more perfectly, and the force generated by the muscles between contraction and retraction, together with the reaction force given by the opponent, can burst out more powerful, so that the most powerful way to subdue the opponent can be played perfectly, and complete their own The process of legitimate defense. Therefore, it is important to evaluate the effectiveness of the exercise program and the quality of the teaching and learning process in order to achieve the best results in teaching taekwondo and to give students the most profound teaching experience. In this paper, we proposed a new approach to evaluating the effectiveness and quality of Taekwondo sports training using optimization algorithms. Specifically, we compared and analyzed three optimization algorithms, TLBO, DSLTLBO, and GWO, for their suitability at different levels of proficiency. Our findings suggest that different optimization algorithms are appropriate for learners at different levels, and a diversified algorithmic approach is recommended for a comprehensive evaluation of the sports plan.

While the findings of this study are promising, there are some limitations to be considered. The adaptivity values presented in the figures may not be easily visible, and future studies could consider adjusting the layout of the figures or using larger font sizes. Additionally, further research is needed to explore how the proposed approach could be further improved or extended to other sports or physical activities.

In conclusion, our study provides valuable insights into the optimization of Taekwondo sports training and highlights the importance of cultivating moral and spiritual values through this martial art. Our findings suggest that optimization algorithms have the potential to improve the effectiveness and quality of sports training, and can be tailored to meet the needs of learners at different levels of proficiency. We recommend that instructors and trainers consider incorporating the use of optimization algorithms into their sports training programs, and future research could explore how this approach could be further improved or extended.

Data Availability Statement

The labeled dataset used to support the findings of this study are available from the corresponding author upon request.

Disclosure Statement

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