Analysis of the Differences in Technical Level of Table Tennis under Different Training Frequencies Based on the Eagle Eye System Measurement

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Abstract: Objective: To study the relationship between the training frequency and technical level of 7-year-old beginners in table tennis, and provide parents with a reference for arranging their children's training frequency.Method: Five 7-year-old children who started training at the same time were selected as the experimental subjects. The weekly training frequency of the five children varied, but the training plan and coach were the same.The technical level of the five children was analyzed through the Eagle Eye system.The results showed that the technical level of children who trained seven times a week was significantly better than that of children who trained four times a week.Therefore, parents should pay attention to and reasonably arrange their children's table tennis training plan to promote their skill development, and it is recommended to insist on training every day of the week.

Keywords: table tennis; Eagle Eye; Training frequency

1 Introduction

Table tennis, as a widely practiced sports event in China, has a long history and profound cultural traditions[1]. Since the 1950s, Chinese players have achieved outstanding results in international competitions, making table tennis one of the most popular and successful sports in China. This success not only increases people's attention to table tennis, but also promotes more children to be exposed to and learn about this sport from a young age[2].

Participating in table tennis training has many benefits for children's growth and development[3]. Especially in the early stages of school age, children's physical fitness develops rapidly and their nervous system forms a stable foundation. By participating in specialized early training, children can comprehensively develop their physical fitness and cultivate skills such as sensitivity, coordination, and responsiveness. In addition, continuous exercise can enhance cardiovascular function, promote bone growth, and cultivate good motor skills and teamwork spirit[4]. Therefore, introducing children into early specialized training under appropriate guidance may have a positive impact on their future healthy development[5].

Learning table tennis techniques has some unique characteristics. Table tennis has various technical types, including forehand attack, backhand attack, forehand pull and charge, backhand rub, and so on. This requires students to master and flexibly apply different technical movements

ITEI 2023, November 24-26, Zhengzhou, People's Republic of China

DOI 10.4108/eai.24-11-2023.2343590

and tactical strategies[6]. In addition, good hand feel is crucial for control and accuracy, and it needs to be cultivated through repeated practice. Due to the high intensity and speed of the competition, high requirements are placed on agility, reaction speed, and visual manual coordination ability. This requires table tennis players to undergo scientific training from an early age and maintain a certain training frequency. The relationship between weekly training frequency and children's technical level is the focus of this study.

2 Experimental methods

2.1 Research subjects

Five 7-year-old elementary school children were selected as the research subjects, and all five children began table tennis training in September 2022. Among them, L received 7 training sessions per week, H received 5 training sessions per week, X received 4 training sessions per week, M received 4 training sessions per week, and Y received 3 training sessions per week. The duration of each training session is 90 minutes, and the coach and training content are basically the same.

2.2 Experimental equipment

The serving machine uses the Galaxy brand serving machine for serving, and the Eagle Eye system is a Bombert brand SEEKER,as shown in Figure 1.The experimental equipment is the Pisces super generation 3 serve machine, and the Hawk Eye system is pombert Hawk Eye seeker.The Hawk Eye system has two high-definition cameras with an 8-core processing chip, which can take 240 photos per second. The camera has a width of 270 ° and stands directly above the center of the table tennis table. When used, the four corners of the table tennis table are marked before recording and testing begins.The simple program code for calculating the ball's past height and speed is shown in the figure 1.

```
import math

# Constants for camera parameters
IMAGE_WIDTH = 1920       # Width of the captured image (pixels)
IMAGE_HEIGHT = 1080      # Height of the captured image (pixels)
CAMERA_FOV = 270         # Camera field of view in degrees

# Constants for table dimensions
TABLE_WIDTH = 1.525      # Width of the table (meters)
TABLE_LENGTH = 2.74      # Length of the table (meters)

# Function to calculate ball passing height above net
def calculate_ball_height(y_coordinate):
    ball_height = y_coordinate - TABLE_WIDTH/2   # Assuming net is at half width position
    return ball_height

# Function to calculate ball speed based on distance traveled and time taken
def calculate_ball_speed(distance, time):
    ball_speed = distance / time   # meters/second
    return ball_speed

# Sample data from tracking algorithm or calculations
x_coordinate = 1.8         # X-coordinate of the detected ball position in meters
y_coordinate = 0.15              # y-coordinate of the detected ball position in meters
z_coordinate    =       1                    # z-coordinate  of      the     detected       ball    position       in      meters
time_taken      =       0.01       # Time taken        for     the     ball    to      travel  that    distance       in seconds

ball_height_result = calculate_ball_height(y_coordinate)
ball_speed_result = calculate_ball_speed(math.sqrt(x_coordinate**2 + z_coordinate**2), time_taken)

print("Ball passing height:", round(ball_height_result, 3), "m")
print("Ball speed:", round(ball_speed_result,3), "m/s")
```

Figure 1. Simple program code for calculating the ball's past height and speed

2.3 Test methods

Evaluate the techniques of forehand and backhand attacks on 5 children, with 100 balls per move and a 0.5 second interval between each ball. Children are required to use technical movements to serve and hit the ball back to the designated area as much as possible. The landing point, quality, and success rate of the return ball are all recorded using the Eagle Eye system.

3 Data analysis

According to the advice given by Eagle Eye, set the landing point, speed, and passing height of the return ball. The standard requirements are: the landing point of the return ball should be at the left bottom corner of the table, the target ball speed is 8.0-12.0 meters/second, and the height of the ball passing through the net is 0.0-0.05 meters.

3.1 Analysis of forehand attack techniques

Figure 2 shows the test results of L, where H has 91 appearances, L has a hit rate of 39%, a return speed rate of 80%, an average ball speed of 8.93 meters/second, a pass height rate of 80%, and an average pass height of 0.07 meters.

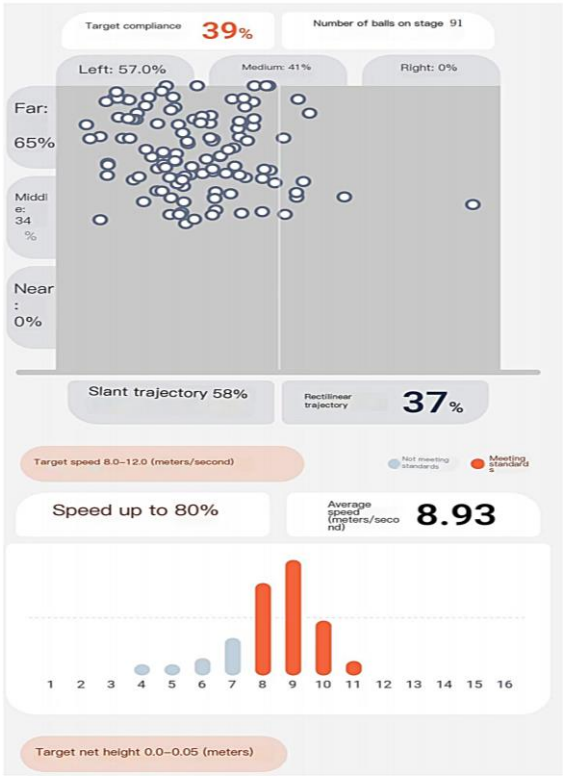

Figure 2. L Forehand Attack Result

Figure 3 shows the test results of H. H is a left-handed athlete, so the landing point is opposite to others. H has 77 appearances, with a landing point compliance rate of 19% and a return speed compliance rate of 83%. The average ball speed is 8.74 meters per second, with a passing height compliance rate of 83% and an average passing height of 0.07 meters.

Figure 3. H Forehand Attack Result

Figure 4 shows the test results of X. X has 85 appearances, with a landing point compliance rate of 11% and a return speed compliance rate of 14%. The average ball speed is 7.08 meters per second, with a passing height compliance rate of 14% and an average passing height of 0.08 meters.

Figure 4. X Forehand Attack Result

Figure 5 shows the test results of M, with 55 appearances, 20% of M's landing point compliance rate, 25% of M's return speed compliance rate, an average ball speed of 7.39 meters/second, 25% of M's passing height compliance rate, and an average passing height of 0.07 meters.

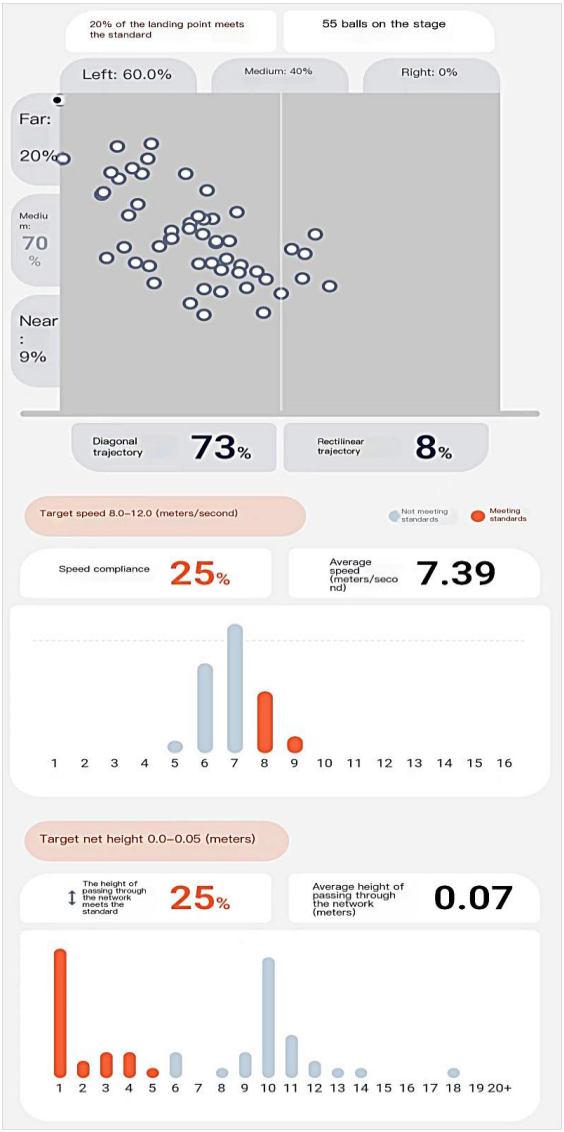

Figure 5. M Forehand Attack Result

Figure 6 shows the test results of Y, with 42 appearances, 45% of Y's landing point compliance rate, 42% of Y's return speed compliance rate, an average ball speed of 7.70 meters/second, 42% of Y's passing height compliance rate, and an average passing height of 0.08 meters.

Figure 6. Y Forehand Attack Result

Based on the comprehensive analysis chart as shown in Figure 7, we can find that there is not much difference in ball speed among the six players, which is directly related to individual strength. However, in terms of the height of the return ball, L and M will be significantly higher than others. The higher the frequency of practice, the lower the trajectory of forehand attack, and the lower the height of passing the net. From the table graph of the ball, it can be seen that the more training times, the more the number of balls on the table. However, the correlation between accuracy and training frequency is not significant, and may be related to the age and control ability of students.

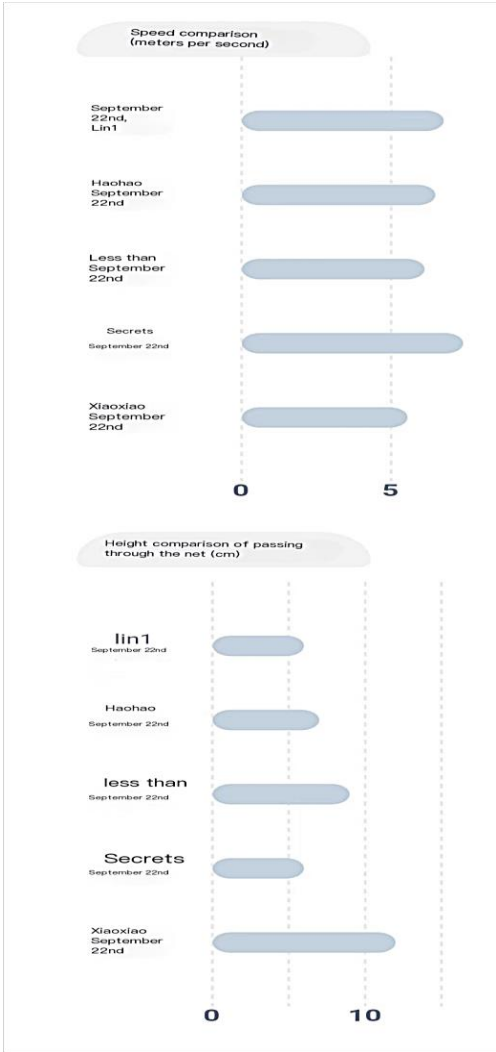

Figure 7. Comprehensive Analysis of Forehand Attack

3.2 Analysis of backhand attack techniques

Figure 8 shows the test results of L, with a number of appearances of 92, a landing point compliance rate of 36%, a return speed compliance rate of 41%, an average ball speed of 6.76 meters/second, a passing height compliance rate of 41%, and an average passing height of 0.06 meters.

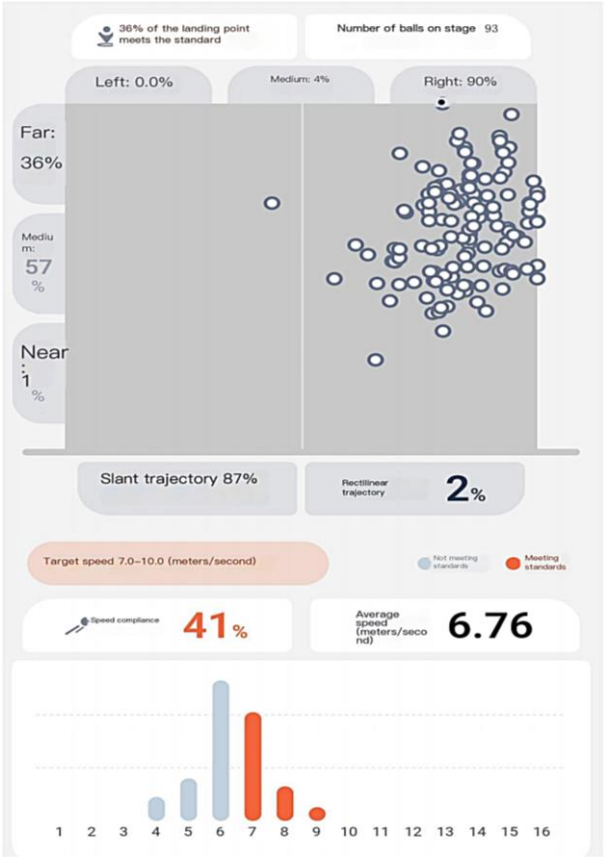

Figure 8. L Backhand Attack Result

Figure 9 shows the test results of H. H is a left-handed athlete, so the landing point is opposite to others. H's number of appearances is 62, H's landing point compliance rate is 17%, return speed compliance rate is 9%, average ball speed is 6.48 meters/second, ball height compliance rate is 9%, and average net height compliance rate is 0.07 meters.

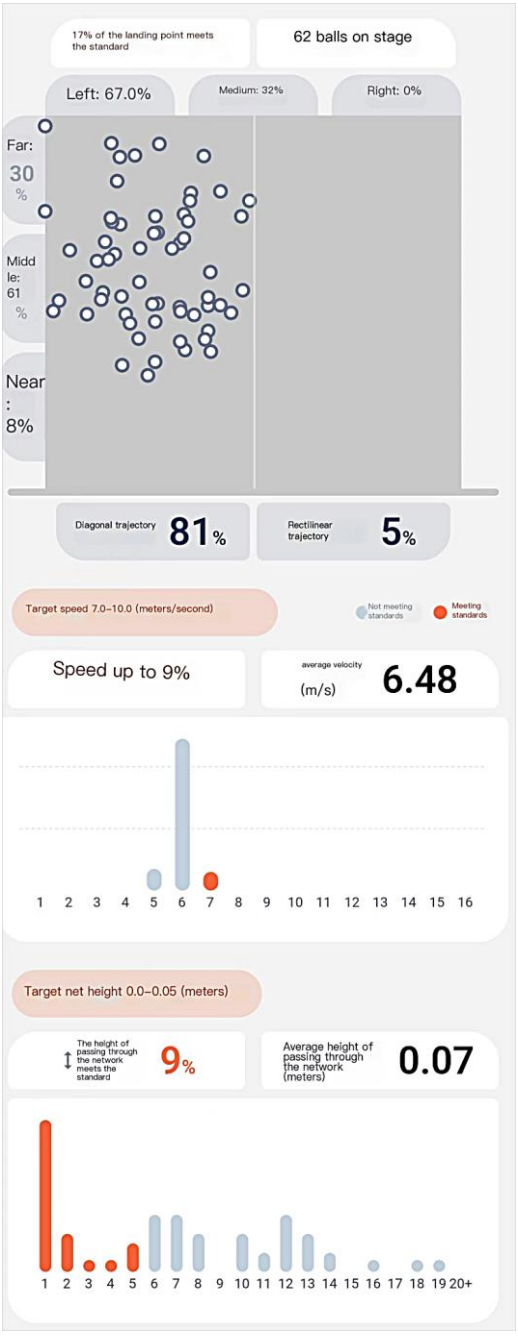

Figure 9. H Backhand Attack Result

Figure 10 shows the test results of X. The number of stages X has reached is 70, the landing point compliance rate of X is 22%, the return speed compliance rate is 0%, the average ball

speed is 5.55 meters/second, the ball passing height compliance rate is 14%, and the average passing height is 0.08 meters.

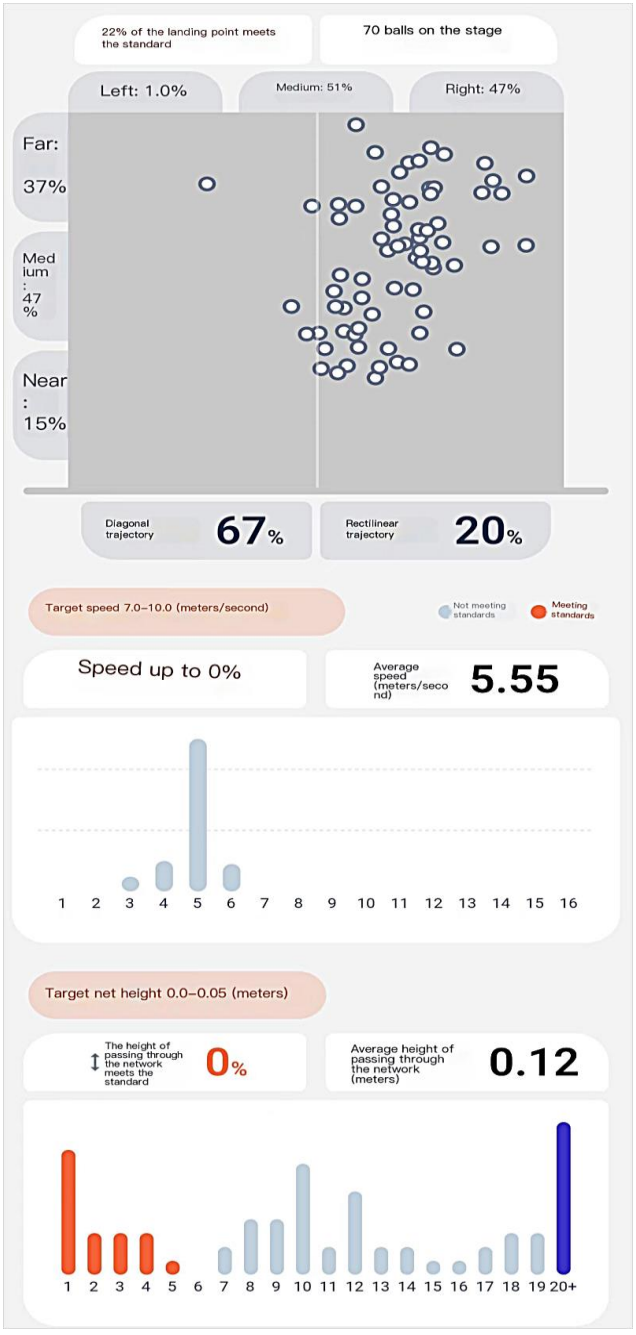

Figure 10. X Backhand Attack Result

Figure 11 shows the test results of M, with 58 appearances, 27% of M's landing point compliance rate, 70% of M's return speed compliance rate, an average ball speed of 7.41 meters per second, 0% of M's passing height compliance rate, and an average passing height of 0.12 meters.

Figure 11. M Backhand Attack Result

Figure 12 shows the test results of Y, with a total of 62 appearances. The landing point compliance rate of Y is 16%, the return speed compliance rate is 11%, and the average ball speed is 6.12 meters/second. The ball's passing height compliance rate is 11%, and the average passing height is 0.09 meters.

Figure 12. Y Backhand Attack Result

Combining the comprehensive analysis of Figure 13, we can see that the backhand technique is more difficult than the forehand technique, requiring a higher level of skill. The ball speeds of L and H are superior to others, and in the past, the heights of L, H, and M were consistent and superior to others.L and H have better ball speeds than others, and their previous heights are consistent and superior to others. Therefore, in terms of difficulty techniques, the frequency of training will be more directly reflected, and students with higher frequencies will be better than other students in all aspects.

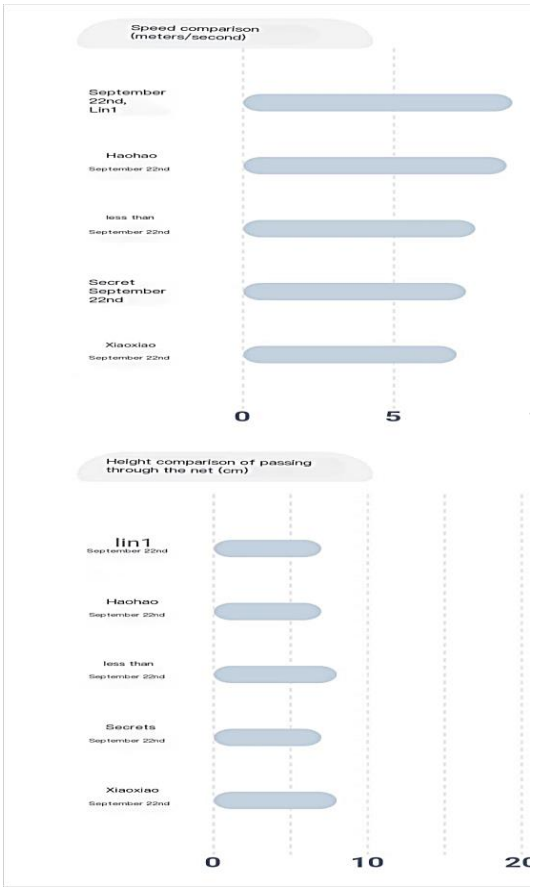

Figure 13. Comprehensive Analysis of Backhand Attack

3.3 Comprehensive analysis

Due to the short training period of the children tested, it is not yet possible to conduct actual competitions to assess their overall level.Therefore, we chose the most basic forehand and backhand techniques as the criteria for measuring their level.These two techniques are tested under the Eagle Eye system for ball return, ball speed, and height over net, and are not affected by differences in height, weight, and strength. They are considered to be effective indicators for measuring the short-term training level of children [7].Through a comprehensive analysis of the forehand and backhand performance of the children tested, we found that children who trained seven times a week were significantly better than other groups in all indicators.For children with other training frequencies, they may have some advantages in one or two performance indicators, but the gap is not significant.It is particularly noteworthy that the gap is more significant in the backhand attack test, indicating that the more difficult techniques require higher frequency training to master.Different training frequencies will eventually show differences in individual technical projects, especially in terms of difficult techniques.

4 Conclusion

Based on the above data analysis, we draw the following conclusions:1. Training daily for table tennis is the best: Through data analysis, we found that daily training for table tennis can achieve the best results.Frequent training helps to consolidate technical movements, improve reaction speed, and hand-eye coordination.Therefore, when developing a children's table tennis training plan, they should be encouraged to adhere to daily training.2. Height and weight have little impact on table tennis skills: According to the data analysis results, there is no clear evidence that height and weight directly affect the performance of 7-year-old children in table tennis skills.This means that even children with a petite physique can learn high-level skills.3. The frequency of training has a greater impact on difficult techniques: Further observation found that there is a greater gap between different training frequencies in more difficult technical events.This means that by increasing the frequency of training, athletes can perform better in mastering difficult techniques.Therefore, when training children's table tennis players, emphasis should be placed on training difficult techniques, and they should be encouraged to increase the frequency of training to improve their level.

Based on the above data analysis results, we propose the following suggestions: For children, it is important to emphasize daily persistence and stable and orderly table tennis training when developing training plans.At the same time, in order to help children quickly improve their technical level, it is necessary to focus on guiding and stimulating their interest in difficult techniques during the teaching process, and encourage them to consolidate and improve their performance by increasing the frequency of training.In addition, attention should be paid to individualized education and guidance methods, and tailored training plans should be developed according to the characteristics and needs of different children, in order to achieve optimal technical development and overall quality improvement.

Acknowledgments. This study is supported by a university-level project of Tianjin University of Technology(YR23-05)

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