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Research Article

Training Method of Flute Breath Based on Big Data of Internet of Things

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As a traditional musical instrument, the flute has a long history and is loved by people. The flute has a wider range, and its timbre has strong penetrating and expressive power. This is not only a unique solo instrument but also occupies an important position in the symphony orchestra. Breath training on the flute is an essential step in flute learning. However, in the traditional flute breath training process, teachers cannot observe the students' practice in real time, and the training process is relatively simple, resulting in the final training effect not being obvious and the students' breath stability not being significantly improved. In order to solve this problem, this paper applied the Internet of Things (IoT) big data technology to the flute breath training process. The flute breath training system based on big data of Internet of Things was used to conduct professional breath training for students. Through the tests of the trained students, it was found that the training method of flute breath using the big data of the Internet of Things improved the students' leg strength and chest, abdomen, and back strength. In the long-tone practice, the students' exhalation time increased by 1.472 seconds, and the students' breath stability increased by 7.1%, which laid a good foundation for the students to learn the flute in the future.

1. Introduction

The rapid development of modern society has led to the gradual improvement of people's living standards. People no longer simply enjoy material life but begin to pursue the spiritual world. With the development of contemporary music, traditional musical instruments have gradually entered people's lives, especially the flute. In the process of playing the flute, the sound of the flute is ethereal and beautiful, which is loved by the world. However, in order to give full play to the sound quality of the flute, high requirements will be placed on the player. The player must conduct breath training on the flute on the basis of playing skills and continuously improve the level of flute playing. In the actual training process, the players should also be trained in terms of leg strength, chest, abdomen, and back strength so as to improve the player's physical quality and lay a good foundation for flute playing. Breath training can effectively improve the player's flute playing ability and play a role in boosting the flute playing career.

Breath control is the flute's most difficult skill to master, but it is also the most important skill. Akka and Aksoy analyzed the flute teaching problems, including breath control, intonation, and finger technique, to help facilitate flute music development and played the flute in a way that combined the best of the East and the West [1]. Ahmed et al. analyzed the signal to study the effect of subtle fluctuations in the frequency and amplitude of each harmonic on the timbre of the flute timbre. The flute sound not only had frequency and amplitude modulation of each harmonic but also had a noise component produced by breathing [2]. Konoval studied the relationship between breath and strength in flute performance by analyzing the scientific application of breath and strength in bamboo flute performance. The three steps of breathing, exhaling, and inhaling during the performance of the bamboo flute were expounded. Combined with the obvious problems in flute teaching, the principle of breathing application and the control of force in playing were analyzed [3]. In the process of playing the flute, due to exhaling and inhaling at the same time, the breathing was supplemented, and the flute was not interrupted, so it was a playing technique that went against the human physiological function and breathing method, which easily led to problems for the player. Moss put forward a brand new flute double spit cycle breathing technique [4]. Keulen et al. elaborated on the relationship between the breath and the mouth of the bamboo flute. Whether the bamboo flute could fully display the charm of music during the performance of the flute was closely related to the control of breathing and mouth. How bamboo flute players practice breath and mouth was pointed out in order to give full play to the artistic charm of the bamboo flute [5]. These studies showed the importance of breath training for flute playing. However, with the development of the times, new problems have emerged.

Internet of Things big data technology has applications in many fields, and more and more researchers are investing in the research of big data technology. Cui utilized big data technology to eliminate the data collected from the virtual world. The proposed methods included singular value decomposition and clustering-based community detection and tensor-based community activity modeling [6]. Yang et al. studied the short-term load forecasting method based on big data, combined with local weighted linear regression and a cloud computing platform. A parallel local weighted linear regression model is established, and the results showed that the proposed improved model of the local weight line for short-term load forecasting was feasible [7]. Rahman et al. introduced a healthcare information system (HIS) framework based on big data analysis in a mobile cloud computing environment, which provided healthcare data among healthcare providers, patients, and practitioners [8]. Ge and Wu conducted correlation analysis and processing of massive medical information through big data technology. Correlations between different factors in the disease life cycle were found, which provided a basis for scientific research and clinical practice [9]. Chen et al. proposed a state-of-the-art computational and fault-based approach based on big data analysis of the smart distribution grid. The data preprocessing results were expanded in space and time to construct a high-dimensional state estimation matrix. Then, the state estimation matrix was analyzed by multidimensional scaling and a local anomaly factor, and the local anomaly factor of each node was calculated [10]. These studies showed that the application of big data technology was very extensive, but it was used less in flute breath training.

This paper proposed a flute breath training method based on IoT. Big data technology was used to build an Internet of Things system for continuous monitoring of breath training. By using the Internet of Things to build an intelligent training environment, learners could better master training skills. Through experiments, it was found that the flute playing level of the trainees was improved.

2. Application of the Internet of Things Big Data in Flute Teaching

2.1. Framework Model of the Flute Breath Training System. This paper uses the big data technology of the IoT to establish a training program based on databases and data mining, which can solve the problems of imperfect data organization and unstable data in the system and give full play to the subject-oriented and analysis-friendly characteristics of data warehouses [11]. OLAP provides a multidimensional directional data analysis model from the data embedded in the database. Multidimensional analysis methods are used to analyze and compare multidimensional data from multiple angles, multiple spaces, and multiple levels. A more natural way of data analysis is provided to the user. The frame model of the flute breath training system is shown in Figure 1 in which the system is supported and managed by metadata.

Data mining can be used directly to guide the performance of online analysis (OLAP), and new knowledge of data mining and statistical analysis can be immediately added to the understanding of the system. Data mining tools and multidimensional analysis tools occupy a major position in flute training systems. The database provides a unified data platform for data mining and data analysis. Model repositories and system repositories can also provide guidance for many analysis tools, while the knowledge base in the model repositories not only enables the discovery of new knowledge but also allows for continuous additions and additions. Therefore, the advantages of data storage and data mining outweigh the disadvantages. The relationship between data, model, method, and technology is combined, which makes full use of data sources in the current system and makes the whole system an organic whole to improve the integration of the system.

2.2. Data Mining Process. Data mining technology refers to extracting knowledge of a person's interests from a large database [12]. Data mining is the product of the combination of many disciplines, such as database technology, artificial intelligence, machine learning, statistical analysis, fuzzy logic, artificial neural networks, and so on. The objectives of data mining are not only organized databases but also semicomplete hypertext documents and even unstructured multimedia data, specifically as shown in Figure 2.

2.2.1. Data Preparation. During the data preparation phase, data from multiple operational data sources need to be consolidated, logical exceptions need to be resolved, lost data need to be recovered, and dirty data need to be cleaned up.

2.2.2. Mining Activities. The mining activity is a process of searching, discovering, entering, and sharing, and it is also the core of the three stages.

2.2.3. Result Presentation and Interpretation. The result presentation and interpretation stage needs to accurately describe the useful information according to the user's ultimate purpose.

2.3. Network Security Configuration Design. Since any Internet of Things teaching system runs on the Internet and it is remote and open, so security is very important for the Internet of Things education system. In the flute breath training

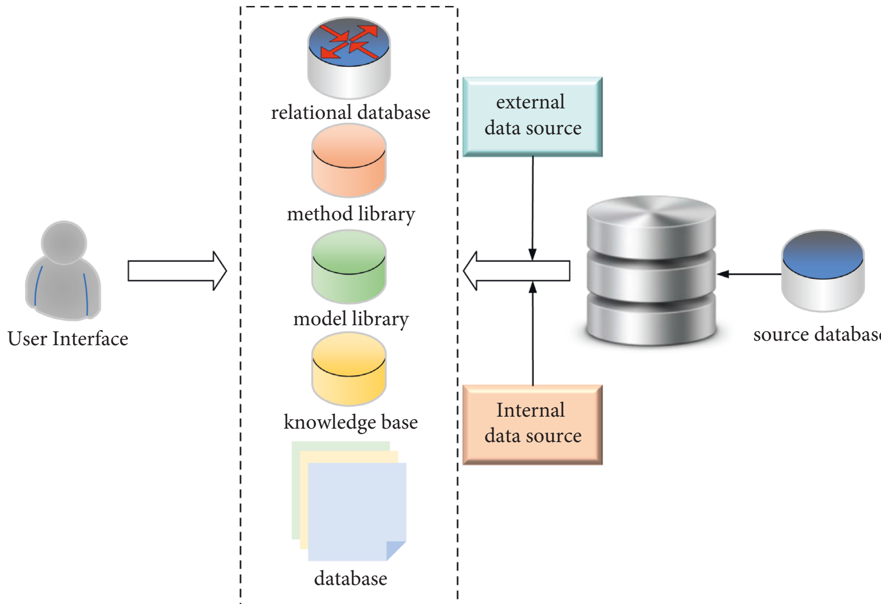

Figure 1: Framework model of the flute breath training system.

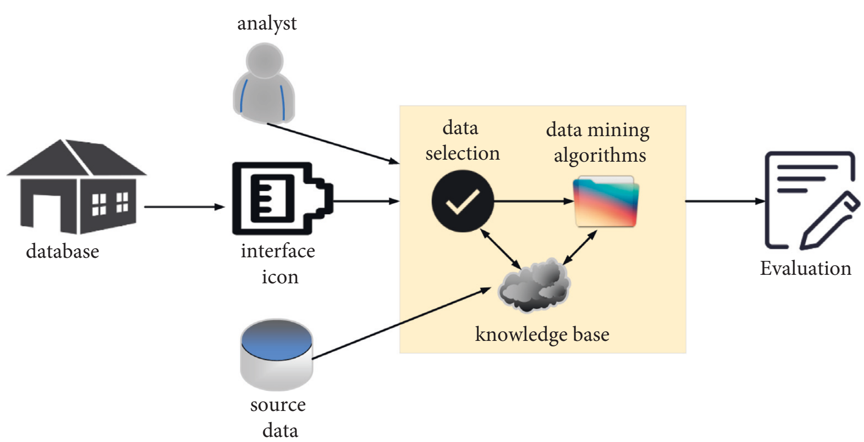

Figure 2: Data mining process.

system, whether it is the information transmitted in the remote access session and branch network or the information in the internal network, the guarantee of the security mechanism is required to protect the information from being leaked and to limit the access of users with different privileges to information at various levels. Therefore, providing efficient security solutions are essential. The flute breath teaching system is configured as J2EE three-level B/S architecture [13]. To meet the configuration requirements of the system, it is necessary to have a certain amount of hardware investment. The flute class computer room is added. The administrator of the educational affairs office is equipped with a management machine, specifically as shown in Figure 3.

The security design of the system is key to the normal operation of the system. The security design of this paper includes the following points.

2.3.1. Different Roles Are Given Different Permissions. This article sets up three roles: teacher, administrator, and student. When users with different roles log into the system, the operation permissions for the same function module are different. When the system is used for the first time, there is only the default role of the administrator. After logging into the system, the administrator can add teacher users, student users, or other administrator users as needed. The

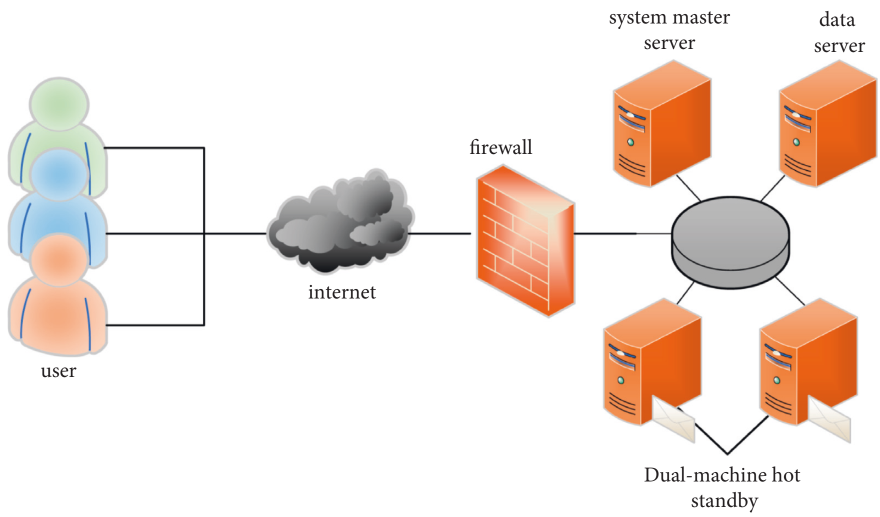

FIGURE 3: Network security configuration design.

administrator is given an initial account and password. When creating a new role user, the corresponding permissions are also granted. When deleting a role user, the user cannot be deleted until it is determined that the role is not associated with it.

2.3.2. Data Backup. The administrator needs to back up the system data regularly. If there is a problem with the system, it can be repaired to a large extent, reducing losses and ensuring the safe operation of the system.

2.3.3. Set Up the Firewall. When running the program, establish a firewall to prevent hackers from invading the system and ensure system security to a greater extent [14].

3. Classification Algorithms

3.1. Decision Tree Classification Algorithm. An important part of decision tree classification algorithms is to find the best features to share. By subdividing the rights of development modules, a decision tree that can distinguish training programs is finally found [15].

The attribute selection metric is a splitting strategy primarily. The splitting strategy is to use the information gain metric on each node of the tree to select attributes, and it is used to determine how the objects on each node are allocated. Usually, those attributes with the maximum information gain are targeted. It can reduce the amount of information generated by sorting data samples and improve data accuracy as much as possible by measuring data information [16, 17].

In the decision partitioning algorithm, the basic operating principle is as follows: suppose that training program B is a random set of materials consisting of x objects with different class symbol values. Suppose $A_i\,(i = 1, 2, \ldots, x)$ are x different classes. $|B|$ is the number of data objects in data system B. Then, $|A_{i,B}|$ is the number of data objects in $A_{i,b}$.

After classifying all the tuples in the training set B, the total amount of information required for adjustment is represented by entropy. Then, the overall process of calculating entropy B is

$$Info(B) = -\sum_{i=1}^{x} p_i \log_2(p_i). \tag{1}$$

Among them, $p_i = |A_{iB}|/|B|$ the training set B is classified according to the y characteristics of the attribute C, that is, C contains y different objects $\{c_1, c_2, \ldots, c_y\}$. Meanwhile, B is divided into y partition $\{B_1, B_2, \ldots, B_y\}$. The information required for classification can be obtained by weighted summation of the entropy of the y partitions, which is expressed as follows:

$$\mathrm{Info}_C(B) = -\sum_{i=1}^{y} \frac{|B_i|}{|B|} \times \mathrm{Info}(B_i). \tag{2}$$

The information gain is

$$\mathrm{Gain}(C) = Info(B) - Info_C(B). \tag{3}$$

Information gain measures the information required for the partition of the training set B according to C. When gain (C) is the largest, its corresponding C is the attribute to be divided, which can minimize the amount of information required to classify the training set B.

3.2. Bayesian Classification Method. The interpretation of Bayesian theory goes like this: suppose M is a data source in a training program and uses the feature y-values to describe M. Assuming that H represents M data which belongs to category C [18], then $p(H|M)$ represents the probability that event H occurs below baseline M, that is, the probability that event H is established below baseline M.

The Bayes rule is as follows:

$$p(H|M) = \frac{P(M|H)P(H)}{P(M)},$$

$$p(A_i|M) = \frac{P(\mathrm{M}|A_i)P(A_i)}{P(M)},$$

$$p(A_i) = \frac{\text{NumberofsamplesbelongingtoclassA}A_i}{\text{Thetotalnumberofsamplesinthetrainingsety}}. \quad (4)$$

The highest probability can only be obtained by increasing the size of $P(M|A_i)P(A_i)$, but since its calculation is very complicated and the value of the formula is very large, it needs to be calculated based on a simple independent order system. $P(M|A_i)$ can be represented by formula (5)

$$(M|A_i) = \prod_{k=1}^{y} P(M_k|A_i) = P(m_1|A_i)P(m_2|A_i).P(m_n|A_i). \quad (5)$$

Among them, m_k represents the value of attribute C_k corresponding to tuple M.

3.3. Least Mean Square Algorithm. Least mean squares (LMS) is an automatic training algorithm [19]. It expresses the difference between the result and the expected result by calculating the difference of the weight vector m. $E(m^*) \leq E(m)$ represents the weight of the iterative network. Through the adjustment of η in the LMS algorithm, within a certain value range, increasing η will reduce the adjustment time, but the system no longer converges when it exceeds this value range [19]. When η is small, the performance of the LMS becomes good.

The vector size is defined using LMS as follows:

$$m_{p+1} = m_p + \Delta m_p = m_p - \eta \nabla E\left(m_p\right) = m_p - \eta \frac{\partial E}{\partial M}. \quad (6)$$

During one computation cycle, training data pairs (m, d) are randomly generated from the training data. Among them, m is the input, and d is the desired response. This leads to the neuron density $f(u)$, whose calculation formula is as follows:

$$u = m^T x. \quad (7)$$

After bringing u into the activation function, the output of the neuron can be obtained as follows:

$$o = f(u) = f\left(m^T x\right). \quad (8)$$

To determine the error size m for a specific condition (m and d), a direct comparison is made between the expected outcome d and the neuron. The error signal is the difference between the expected result and the result.

$$e = d - o = d - \left(m^T x\right). \quad (9)$$

The error E is used to measure neuron size and adjust to reduce the charge across the network density. The atypical deviation function of E with weight m is a parabolic surface function with a hollow center of mass. This is relatively a small amount of function, which can effectively reduce the charge function value. The dip angle can be used to find the minimum next to the paraboloid [20].

The formula for E is as follows:

$$E = \frac{1}{2} e^2 = E(m). \quad (10)$$

The value corresponding to the function E for each score of the vector weight m is the degree.

$$\nabla E(w) = \frac{\partial E}{\partial u} \frac{\partial u}{\partial m}. \quad (11)$$

Among them, $\partial E/\partial u$ is called the error signal, which is used to measure the degree of change of the error when the input of u changes. $\partial u/\partial m$ is used to measure the degree of influence on the weight vector m when calculating a specific input u. By applying the chain rule to formula (13) again, the formula is as follows:

$$\nabla E(m) = \frac{\partial E}{\partial e} \frac{\partial e}{\partial o} \frac{\partial o}{\partial u} \frac{\partial E}{\partial m}. \quad (12)$$

Differentiating e on both sides of formula (12) is as follows:

$$\frac{\partial E}{\partial e} = e. \quad (13)$$

At the same time, both sides of formula (11) are simultaneously differentiated for o as follows:

$$\frac{\partial E}{\partial e} = -1. \quad (14)$$

At the same time, both sides of formula (10) are simultaneously differentiated for u as follows:

$$\frac{\partial o}{\partial u} = f'(u). \quad (15)$$

Finally, both sides of formula (9) are simultaneously differentiated for m as follows:

$$\frac{\partial u}{\partial m} = x. \quad (16)$$

Therefore, the first derivative of the charge function E with respect to the weight m can be expressed as follows:

$$\nabla E(m) = -ef'(u)x. \quad (17)$$

The LMS rules are

$$m_{p+1} = m_p + \Delta m_p = m_p - \eta \nabla E\left(m_p\right) = m_p + \eta e_p f'\left(u_p\right) x_p. \quad (18)$$

4. Training Method of Flute Breath

In the process of playing the flute, it is necessary to maintain a close connection between spirit and timbre. The sound of the flute is guaranteed to be beautiful through the timbre, and the timbre of the flute can be maintained for a longer time through breath training. In the actual training process, the player's breath should be trained by inhaling and exhaling, but there is a certain correlation between the timbre of the flute and the breath. For example, the breath training of the flute requires the player to have good physical fitness so as to ensure normal performance. When the player's body is full of breath, the body is in a state of high oxygen, which keeps the body stable. In the context of this situation, the player can drive the vocal part by exhaling and inhaling, effectively playing a beautiful flute sound.

4.1. Experimental Process. To test the impact of IoT big data on students' in flute breath training and teaching, the following experiment was carried out: 10 flute students were randomly selected. In order to avoid experimental errors, the testers were all flute beginners. Among them, 5 people were in the experimental group, and 5 people were in the control group. The control group was trained according to the traditional flute breath training method. The experimental group was trained according to the training method of flute breath based on IoT big data. The training period was 6 months. During the training, the experimental group and the control group were subjected to the leg strength test, the chest, abdomen, and back strength test, the long-tone exercise test, and the breath stability test. By observing and comparing the test results of the experimental group and the control group, the impact of the flute breath training method based on the big data of the IoT on the students is analyzed.

4.2. Experimental Data. In order to avoid experimental errors, the students who take the test are not much different in age and have the same flute playing level. The specific data of the students are shown in Table 1.

4.3. The Purpose of the Experiment. In order to obtain the effect of flute players' reasonable and effective breath training, IoT big data technology is applied to flute breath training teaching. At the same time, the impact of Internet of Things big data technology on players' flute breath training is observed.

5. Impact of Internet of Things Big Data on Flute Breath Training

5.1. Leg Strength Test. Good physical fitness is the basic guarantee for a player to perform. Leg strength training for the player will allow the player to keep their body stable while playing. The stronger the player's legs, the stronger the waist and lungs, the more stable the breath output and the better the performance. The students in the experimental group and the students in the control group are given leg strength training, and the results are recorded once a month to analyze the differences between the two groups. The results are shown in Figure 4.

In Figure 4, Figure A is the result of the leg strength test of the students in the control group, and Figure B is the result of the leg strength test of the students in the experimental group. With the increase of training time, the leg strength index of the students in the control group and the experimental group also increased. Among them, in the control group, the leg strength index of student 1 increased from 6.9 to 7.4, and the index increased by 0.5. Student 2's leg strength index increased from 6.8 to 7.2, and the index increased by 0.4. Student 3's leg strength index increased from 7 to 7.4, and the index increased by 0.4. Student 4's leg strength index increased from 7.1 to 7.6, and the index increased by 0.5. Student 5's leg strength index increased from 6.9 to 7.4, and the index increased by 0.5. In the experimental group, student 6's leg strength index increased from 6.8 to 7.9, and the index increased by 1.1. Student 7's leg strength index increased from 7 to 7.9, and the index increased by 0.9. Student 8's leg strength index increased from 6.9 to 8, and the index increased by 1.1. Student 9's leg strength index increased from 7.1 to 8.1, and the index increased by 1. Student 10's leg strength index increased from 6.9 to 8.1, and the index increased by 1.2. To sum up, the leg strength index of the students in the control group increased by 2.3. The leg strength index of the students in the experimental group increased by 5.3. The leg strength training effect of the students in the control group is better.

Table 1: Experimental data.

	Age	Gender	Contact flute time	Daily practice time
1	17	Male	4 months	>1 hour
2	17	Female	2 months	1 hour
3	18	Female	3 months	<1 hour
4	16	Male	4 months	<1 hour
5	19	Female	3 months	>1 hour
6	20	Female	2 months	1 hour
7	18	Male	3 months	1 hour
8	19	Female	3 months	<1 hour
9	16	Female	4 months	>1 hour
10	17	Male	2 months	<1 hour

5.2. Strength Test of the Chest, Abdomen, and Back. Players need to use their chest, abdomen, and back strength when playing the flute. The chest, abdomen, and back strength training for the player can improve the storage capacity of the player's inhaled breath and improve the sound quality of the flute. In the training process, students should combine the strength of the waist to make the inhaled gas form a column of air in the body and cooperate with the chest to exhale so that they can find the scientific breath and adjust it. The two groups of students are given thoracic, abdominal, and back strength training, and the statistical results are analyzed. The results are shown in Figure 5.

In Figure 5, with the increase of training time, the strength index of the chest, abdomen, and back also increased for the students in the control group and the experimental group. Among them, in the control group, student 1's chest, abdomen, and back strength indexes increased from 6.8 to 7.5, and the index increased by 0.7. The thoracic, abdominal, and back strength indexes of student 2 increased from 6.9 to 7.4, and the index increased by 0.5. Student 3's chest, abdomen, and back strength indexes

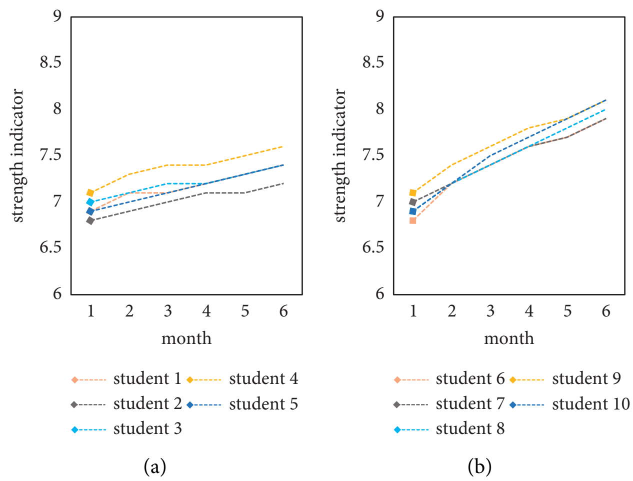

Figure 4: Leg strength test. (a) The control group and (b) the test group.

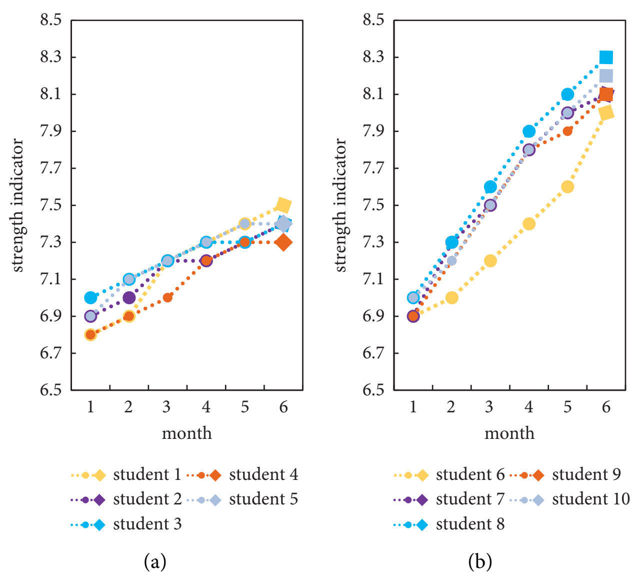

Figure 5: Chest, abdominal, and back strength test. (a) The control group and (b) The test group.

increased from 7 to 7.4, and the index increased by 0.4. The thoracic, abdominal, and back strength indexes of student 4 increased from 6.8 to 7.3, and the index increased by 0.5. The thoracic, abdominal, and back strength indexes of student 5 increased from 6.9 to 7.4, and the index increased by 0.5. In the experimental group, the thoracic, abdominal, and back strength indexes of student 6 increased from 6.9 to 8, and the index increased by 1.1. The thoracic, abdominal, and back strength indexes of student 7 increased from 6.9 to 8.1, and the index increased by 1.2. The thoracic, abdominal, and back strength indexes of student 8 increased from 7 to 8.3, and the index increased by 1.3. Student 9's chest, abdomen, and back strength indexes increased from 6.9 to 8.1, and the index increased by 1.2. The thoracic, abdominal, and back strength indexes of student 10 increased from 7 to 8.2, and the index increased by 1.2. To sum up, the thoracic, abdominal, and back strength indexes of the students in the control group increased by 2.6. The strength of the chest, abdomen, and back of the students in the experimental group increased by 6. The chest, abdomen, and back strength training effects of the students in the control group are better. Internet of Things big data technology can better help teachers train students.

5.3. Long Tone Practice Test. Long tone exercises are the most common form of breath training. Long tone practice requires the player to keep exhaling for a long time in order to make the tone more stable. Long tone practice requires students to maintain breath in the two states of exhalation and inhalation. Through repeated training, students' breathing time can be increased. The students in the control group performed traditional long tone exercises, while the students in the experimental group performed long tone

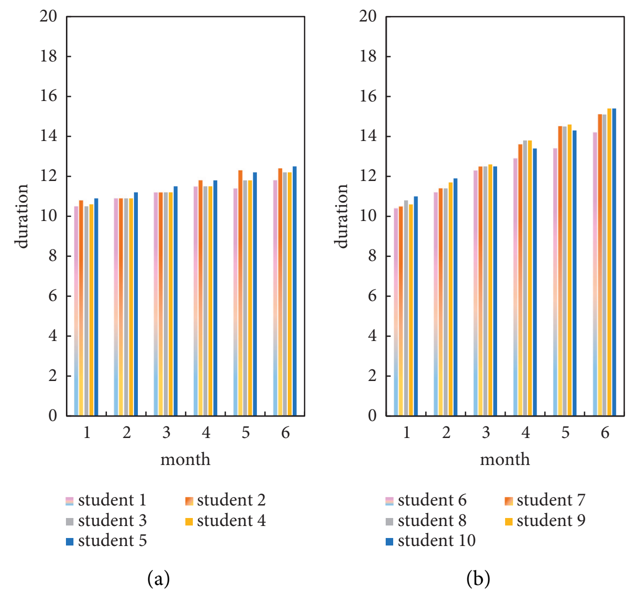

Figure 6: Long tone practice test. (a) The control group. (b) The test group.

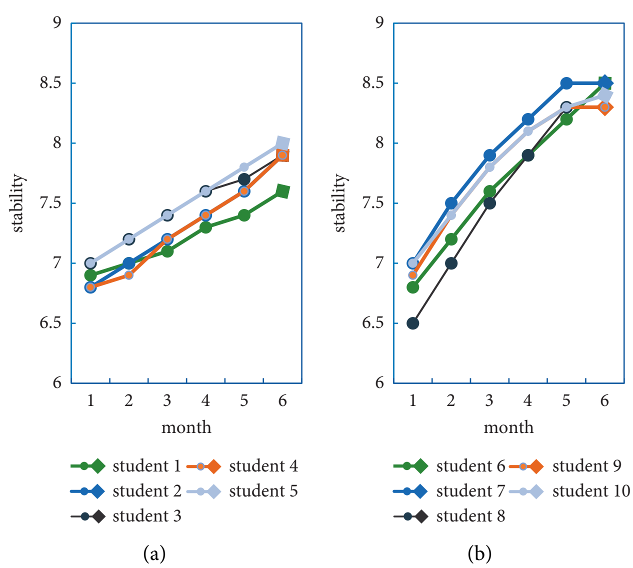

Figure 7: Breath stability test. (a) The control group. (b) The test group.

exercises based on the big data of the IoT. Then, the two groups of students are subjected to a breath test to observe the difference in the test results of the two groups of students. The specific results are shown in Figure 6.

In Figure 6, both the students in the experimental group and the students in the control group experienced an increase in the length of exhalation after 6 months of long tone practice. The growth rate of the experimental group is faster than that of the control group. Among them, in the control group, the average exhalation time of student 1 is 11.22 seconds. Student 2's average expiratory time is 11.57 seconds. Student 3's average exhalation time is 11.35 seconds. Student 4's average expiratory time is 11.37 seconds. Student 5's average expiratory time is 11.68 seconds. In the experimental group, student 6's average expiratory time is 12.4 seconds. Student 7's average expiratory time is 12.93 seconds. Student 8's average expiratory time is 13.02 seconds. Student 9's average expiratory time is 13.12 seconds. Student 10s average exhalation time is 13.08 seconds. To sum up, the average expiratory time of the students in the control group is 11.438 seconds. The exhalation time of the students in the experimental group is 12.91 seconds. Applying the big data technology of the IoT to the long tone practice, the students' exhalation time increased by 1.472 seconds.

5.4. Breath Stability Test. Players need to keep their playing breath stable during flute playing. The more stable the breath, the better the performance. The stability test is conducted on the students in the experimental group and those in the control group. After 6 months of breath testing, whether there is any change in the students' stability and the difference between the two groups of students' stability are observed. The specific results are shown in Figure 7.

In Figure 7, Figure A is the breath stability test result of the control group, and Figure B is the breath stability test result of the experimental group. The breathing stability of the students in the experimental group increased faster. Among them, after 6 months of training in the control group, the stability of student 1 increased to 7.6. The stability of student 2 increased to 7.9. Student 3's stability increased to 7.9. Student 4's stability increased to 7.9. Student 5's stability increased to 8. The average stability of the students in the control group is 7.86. After 6 months of training in the experimental group, the stability of student 6 increased to 8.5. Student 7's stability increased to 8.5. Student 8's stability increased to 8.4. Student 9's stability increased to 8.3. Student 10's stability increased to 8.4. The average stability of the students in the experimental group is 8.42. To sum up, the flute breath training for students based on the big data of the IoT improves the students' breath stability by 7.1%.

6. Conclusion

Improvement in the flute player's performance level can help the player to perform breath training more accurately and comprehensively. This paper applied the IoT big data technology to the flute breath training process to help teachers better conduct flute breath training for students, which enabled students to master the basic training essentials. When the students performed breath training, the training movements of those students were observed in real time to maintain the accuracy of training. Through experimental tests on students, it was found that the application of Internet of Things big data technology to the process of breath training could effectively improve students' physical fitness and the stability of students' flute breath, which was of great help to students' follow-up learning. In addition, it could also be found that the big data technology of the IoT could effectively improve the training rate of students and promote the all-round development of students.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The author declares no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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