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ORIGINAL

RESEARCH ON TEACHING MODEL OF SWIMMING SKILLS TRAINING IN COLLEGES AND UNIVERSITIES UNDER THE BACKGROUND OF ARTIFICIAL INTELLIGENCE

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ABSTRACT

This paper studies how to construct a teaching model suitable for swimming skill training in colleges and universities under the background of artificial intelligence. Firstly, the combination trend of artificial intelligence and swimming skill training is analyzed. Secondly, a teaching model based on artificial intelligence is constructed with the background of swimming teaching in colleges and universities. Through the collection and analysis of swimming action data, students' swimming skills are intelligently evaluated and fed back to improve the teaching quality. At the same time, combined with the actual situation, the model design and research and development of artificial intelligence in swimming teaching in colleges and universities are discussed. Through practical application, the validity and feasibility of the teaching model are verified, which provides a useful reference for swimming teaching in colleges and universities.

KEYWORDS: Artificial intelligence; Deep learning; Training model

1. INTRODUCTION

With the rapid development of science and technology, artificial intelligence has gradually penetrated into various fields, and the education industry is no exception (Nsoh, Joseph, & Adablanu, 2023). Under the background of artificial intelligence (Rosak-Szyrocka, Żywiołek, Nayyar, &

Naved, 2023), the research on the teaching model of swimming skill training in colleges and universities has become a brand-new topic (Li, 2023). This paper aims to explore the application of artificial intelligence technology in swimming teaching in colleges and universities, in order to provide new ideas and methods for improving the quality and effect of swimming teaching (Xu & Xu, 2023). As an important sport, swimming can not only exercise and improve physical fitness, but also cultivate students' courage, tenacity, unity and cooperation spirit. However, the traditional swimming teaching model has some limitations, such as insufficient teachers' resources, single teaching methods and poor students' learning effect (Cui & Mingfei, 2023; Franco, González-Peño, Trucharte, & Martínez-Majolero, 2023).

The introduction of artificial intelligence technology can provide a brand-new solution for swimming teaching. Artificial intelligence technology can optimize the allocation of swimming teaching resources: through big data analysis and cloud computing technology, swimming teaching resources can be efficiently integrated, teachers, venues, equipment and other resources can be rationally allocated (Cui & Mingfei, 2023; Zeebaree, 2024), and the popularity and coverage of swimming teaching can be improved; Artificial intelligence technology can also innovate swimming teaching methods: with the help of intelligent teaching system, targeted training plans can be made according to students' individual differences and needs to realize personalized teaching (Hou et al., 2024; Xurui & Guobao, 2023). At the same time, through virtual reality technology and augmented reality technology, we can provide students with an immersive swimming learning experience and improve their learning interest and enthusiasm; Artificial intelligence technology can improve the effect of swimming teaching: through the capture and analysis of students' swimming movements, students' swimming skills can be fed back in real time and targeted improvement suggestions can be provided for students (Jafar, Rinaldy, & Yunus, 2023).

At the same time, through the intelligent training evaluation system, students' swimming skills can be evaluated scientifically and comprehensively, which can provide teaching reference for teachers. Artificial intelligence technology can promote the exchange and cooperation of swimming teaching: through the Internet and Internet of Things technology, swimming teaching resources can be shared (Su, Tseng, Cheng, & Lai, 2024), communication and cooperation among teachers can be promoted, and the overall level of swimming teaching can be improved. To sum up, under the background of artificial intelligence, it is of great practical significance to study the teaching model of swimming skill training in colleges and universities. In this paper, the application of artificial intelligence technology in swimming teaching will be deeply discussed in order to provide useful reference for improving the quality and effect of swimming teaching in colleges and universities in China.

2. Literature review

2.1 Overview of artificial intelligence

Artificial Intelligence (AI), as an interdisciplinary research field, has attracted much attention since it was born in 1950s. It mainly studies and develops theories, methods, technologies and application systems for simulating, extending and expanding human intelligence. Artificial intelligence involves computer science, psychology, philosophy and other disciplines, aiming at revealing the essence of intelligence and creating machines that can imitate human intelligent behavior (Doroudi, 2023; Khaleel & Jebrel, 2024). Artificial intelligence covers many industries and is constantly expanding and infiltrating into other fields (Chaurasia, Parashar, & Kautish, 2023; Jan et al., 2023). The market scale of artificial intelligence related industries in China from 2019 to 2025 is shown in the following figure:

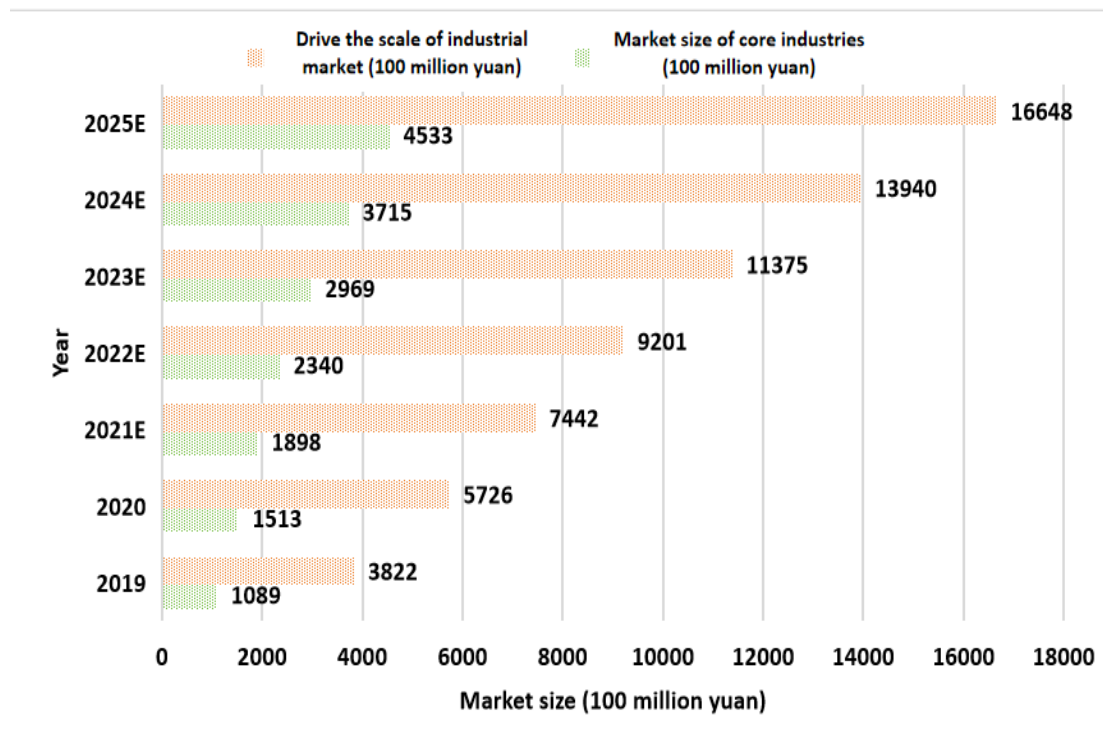


Figure 1: Market Scale of Artificial Intelligence Related Industries in China from 2019 to 2025

The development of artificial intelligence has brought opportunities for transformation and upgrading to all walks of life (Chelliah, Jayasankar, Agerstam, Sundaravadivazhagan, & Cyriac, 2023; George, 2024). It has become a new engine to promote economic growth and social development by improving efficiency, reducing costs and creating new business models. With the continuous progress of technology, it is expected that more industries and industries will be integrated into the category of artificial intelligence in the future. The statistics of industry share in China's artificial intelligence market are shown in the following figure:

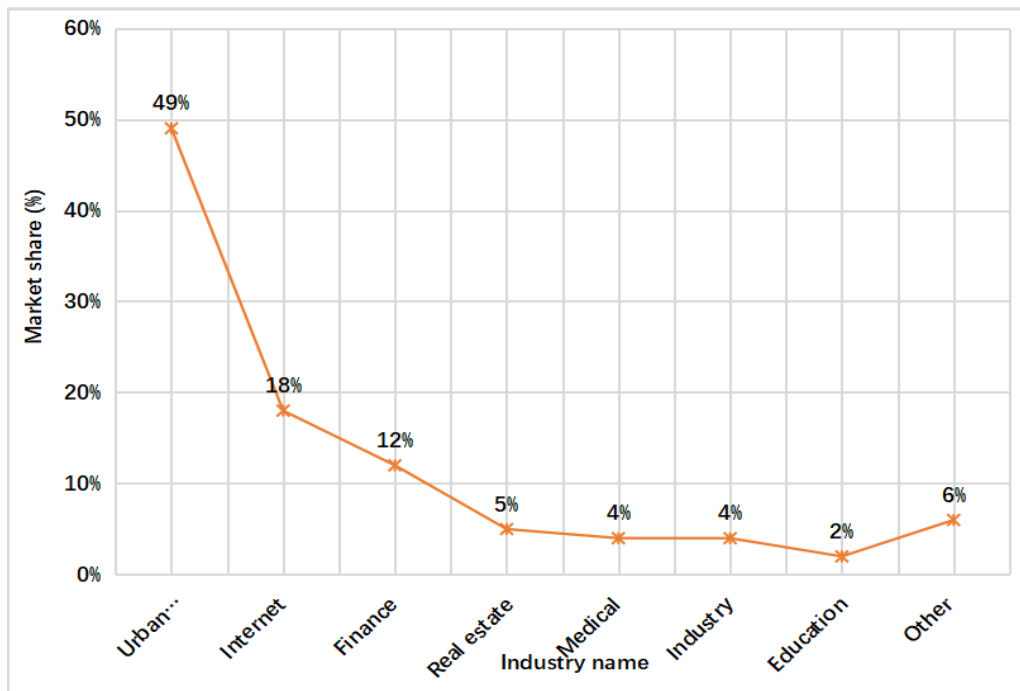


Figure 2: Statistics on the proportion of industry share in China's artificial intelligence market

Artificial intelligence includes many sub-fields and branches, such as machine learning (ML): Machine learning is one of the core branches of artificial intelligence, which enables computer systems to learn and improve from data automatically through algorithms and statistical models without explicit programming. Machine learning algorithm is applied to image recognition, speech recognition, natural language processing and other fields. In addition, there is deep learning (DL): Deep learning is a sub-field of machine learning, which depends on artificial neural networks, especially deep neural networks. These networks can learn and extract the complex features of input data, thus achieving efficient classification, recognition and other tasks. In deep learning, the loss function is a key component to evaluate and optimize the performance of neural networks. Specifically, the loss function measures the inconsistency between the model output and the actual data, that is, the prediction error. In supervised learning, the loss function is used to guide the training process of the model. The purpose is to make the prediction of the model as close as possible to the real label by adjusting the weight and bias of the network. The choice of loss function has an important influence on the performance of the model and the training process. Different loss functions have their specific application scenarios, advantages and disadvantages, so it is very important to choose the appropriate loss function for building an efficient and accurate model. There are several loss functions: (1) Average absolute error loss (MAE loss function): Also known as L1 loss function, it takes the absolute error between the predicted value and the real value as the distance. Its mathematical expression is shown in the following formula:

$$J_{MAE} = \frac{1}{N} \sum_{i=1}^N |y_i - \hat{y}_i| \quad (1)$$

(2) Mean square error loss (MSE loss function): also known as L2 loss function or Euclidean distance, it takes the sum of squares of errors as the distance, which is the most commonly used loss function in regression tasks. Its expression is shown in the following formula:

$$J_{MSE} = \frac{1}{N} \sum_{i=1}^N (y_i - \hat{y}_i)^2 \quad (2)$$

(3) Hinge loss function: It is a two-classification loss function, which is suitable for the classification of max-margin, so it is often used in SVM model. The expression of Hinge loss is shown in the following formula:

$$J_{Hinge} = \sum_{i=1}^N \max(0, 1 - y_i \hat{y}_i) \quad (3)$$

Among them, $\hat{y}_i \in (-1, 1)$, y_i is ± 1 , represents the positive and negative samples in the binary classification. (4) CE loss function: CE is an important concept in information theory, which is mainly used to measure the difference information between two probability distributions. Suppose there are two probability distributions p and q , where p represents the real distribution and q represents the predicted distribution, then the difference information between them can be expressed by cross entropy, and its expression is shown in the following formula:

$$H(p, q) = \sum_x p(x) \log\left(\frac{1}{q(x)}\right) = - \sum_x p(x) \log q(x) \quad (4)$$

2.2 Classification of swimming skills

Swimming is an ancient and charming sport, which can not only exercise, enhance heart and lung function, but also improve coordination ability, and it is also a survival skill. Swimming skills are varied. According to the principles of sports physiology and sports biomechanics, swimming skills can be roughly divided into the following categories: (1) Freestyle: Freestyle is one of the most common and natural swimming postures. It hardly needs any special training, and it is a natural swimming style. Freestyle mainly relies on the free swing of the body and the kicking of the legs, while the arm is mainly responsible for maintaining the balance of the body and adjusting breathing. (2) Breaststroke: Breaststroke is an ancient swimming style, and its movements imitate the swimming posture of frogs, hence its name. Breaststroke is a very suitable swimming style for beginners because it is easier to learn and master. Breaststroke is mainly propelled by arm strokes and leg kicks. (3) Backstroke: Backstroke is a swimming style with the body facing down. It is characterized

by relaxation and comfort, which is very suitable for relaxation and rest. Backstroke is mainly propelled by arm stroke and leg kick. (4) Butterfly: Butterfly is a very elegant and ornamental swimming style, and its movements imitate the flying posture of butterflies, hence its name. Butterfly stroke is a swimming style that tests physical fitness and swimming skills. Its movements are complex and require strong muscle control and coordination. Butterfly stroke mainly relies on arm stroke, leg kick and body fluctuation to advance. In a word, each swimming skill has its own unique characteristics and advantages. When learning to swim, you can choose a suitable swimming style according to your own preferences and needs. At the same time, no matter which swimming mode you choose, you need to master the correct swimming skills and methods, so as to enjoy the fun of swimming better and achieve the swimming effect more effectively.

2.3 Current situation of swimming skill training and teaching in colleges and universities

Swimming, as a sport with a long history, not only has the function of strengthening the body, but also can effectively improve people's cardiopulmonary function, and it is also a survival skill. In physical education teaching in colleges and universities, swimming courses are designed to enable students to master swimming skills, improve their physical fitness and enhance their safety awareness of water activities. At present, the following situations generally exist in the training and teaching of swimming skills in colleges and universities in China:

(1) Curriculum and teaching contents: Most colleges and universities will set up basic teaching contents in swimming courses, including the basic swimming posture, breathing skills, breaststroke, freestyle and other basic swimming strokes. In the teaching process, teachers will gradually improve the teaching difficulty according to the students' mastery, so as to make students master swimming skills skillfully.

(2) Teaching methods and means: In swimming skill training, teachers will comprehensively use various teaching methods such as explanation, demonstration, correction and counseling. At the same time, in order to improve students' learning interest and enthusiasm, teaching methods are constantly innovating, such as using underwater photography equipment to assist students to observe their swimming posture or organizing swimming competitions.

(3) Students' level is uneven: Because students' swimming foundation is different, teachers need to make different teaching plans for students of different levels in the teaching process. For beginners, the key is to lay a solid foundation; For students who have a foundation, they pay attention to improving

and strengthening their skills.

(4) Safety: The safety of swimming course is particularly important. Colleges and universities usually formulate strict safety rules and regulations, requiring students to wear life jackets during class, and teachers will also supervise the whole process to ensure the safety of students in the water.

(5) Teaching resources: At present, most colleges and universities have certain swimming teaching resources, such as indoor swimming pools, lifeguards and teaching equipment. However, some colleges and universities still have some difficulties in developing swimming courses because of limited resources. In short, the training and teaching of swimming skills in colleges and universities in China is making continuous progress, but it is still necessary to continue to strengthen management in the allocation of teaching resources and the safety of students in order to improve the teaching quality and students' swimming skills.

2.4 The combination trend of artificial intelligence and teaching model

With the continuous progress of artificial intelligence technology, its application in physical education is increasingly integrated with various teaching models. For example, artificial intelligence can be combined with "flip classroom" mode, and personalized learning resources can be provided through intelligent preview system, so that students can master basic knowledge before class, thus focusing on practical training and problem discussion in class, which greatly improves classroom efficiency. For another example, artificial intelligence can also be combined with the "blended learning" mode, and the intelligent online learning system can be used to provide students with personalized learning services anytime and anywhere, and in-depth practice can be carried out through offline classroom links to realize the organic integration of online and offline. Generally speaking, artificial intelligence will be deeply integrated with all kinds of advanced teaching models, and promote the continuous development of physical education in the direction of intelligence, personalization and efficiency. Artificial intelligence technology has a broad application prospect in swimming training. First of all, artificial intelligence can accurately capture the details of swimming movements through visual recognition and action analysis, and provide professional correction opinions to help students quickly master the correct swimming techniques. Secondly, the artificial intelligence system can make personalized training plan, arrange training intensity reasonably and maximize training effect according to the physical condition of students. Moreover, artificial intelligence can also be combined with the monitoring equipment of swimming pool to analyze the swimming state of students in real time, find abnormal situations in time and ensure the safety of training. Generally speaking, artificial intelligence technology provides all-round intelligent support for swimming training and will

play an increasingly important role in swimming teaching in the future.

3. Design of swimming teaching model based on artificial intelligence

3.1 The main modules of swimming teaching model

The swimming teaching model mainly consists of the following modules: Motion analysis module. This module is mainly responsible for real-time analysis and feedback of students' swimming movements. Through computer vision technology, combined with the action standard accumulated by experts' experience, the movement deviation of students is detected in real time, and targeted correction suggestions are given. Voice interaction module. The module adopts advanced speech recognition and synthesis technology, which can realize the speech interaction between teachers and students. Coaches can give real-time guidance to students through voice commands, and students can also ask questions through voice to enhance communication and interaction between teachers and students. Personalized recommendation module. Based on the information of students' learning and physical condition, this module uses machine learning algorithm to make personalized recommendations on training plans. According to the students' actual level and acceptance ability, recommend appropriate training courses to help students make the best training plan. Teaching management module. This module is responsible for the intelligent management of the whole teaching process. Including student information management, curriculum arrangement, teaching progress tracking and other functions to help coaches carry out teaching work more efficiently.

3.2 Design and development of interactive interface

In order to enhance the user experience, the design of interactive interface is very important. The interactive interface of this model mainly includes the following parts: Action analysis interface. The interface displays the swimming movements of students in real time, and gives corresponding analysis and correction suggestions to help students find and correct wrong movements in time. The interface design needs to be intuitive and clear, which is convenient for students to understand and accept quickly. Voice interactive interface. The interface supports voice interaction between teachers and students. Coaches can give real-time guidance to students through voice commands, and students can also ask related questions by voice. Interface design needs to be simple and easy to use, reducing interaction barriers. Personalized recommendation interface. According to the personal information of the trainees, the interface gives targeted training plan recommendations. Interface design needs to be friendly and intuitive to help students quickly understand and accept the corresponding training program. Teaching management interface. This interface provides coaches with functions such as

teaching progress tracking and course arrangement, which helps them to manage teaching activities better. Interface design needs rich functions and simple operation to improve the work efficiency of coaches.

3.3 Research and Optimization of Core Algorithm Module

In this study, action analysis algorithm, voice interaction algorithm and personalized recommendation algorithm are illustrated respectively. Motion analysis algorithm: This algorithm is mainly based on computer vision technology, combined with expert experience, to analyze and judge the swimming movements of students in real time. Key technologies include attitude estimation, motion recognition, error detection, etc. Through the training and optimization of deep learning model, the accuracy and real-time performance of motion analysis are continuously improved. Speech interaction algorithm: This algorithm involves speech recognition, speech synthesis and other technologies. Through the training of a large number of voice data, the recognition accuracy is improved, and natural and smooth voice output is generated, thus achieving efficient communication between teachers and students. At the same time, we also need to deal with noise interference, accent differences and other issues in the process of voice interaction. Personalized recommendation algorithm: This algorithm is mainly based on machine learning technology. By analyzing students' historical learning data, physical condition and other information, personalized learning portraits are established, and the optimal training plan is recommended accordingly. Key technologies include collaborative filtering, content recommendation, etc. It is necessary to continuously optimize algorithm parameters to improve the accuracy and pertinence of recommendation.

3.4 technical realization and hardware support of the model

To realize the swimming teaching model based on artificial intelligence, it is necessary to have corresponding hardware and software support. Hardware: High-performance cameras, microphones and other equipment are needed for motion analysis and voice interaction. At the same time, it is necessary to have enough computing power to support the real-time operation of the core algorithms. Software: Functional modules such as action analysis, voice interaction and personalized recommendation need to be developed and integrated into a unified teaching system. At the same time, it is necessary to optimize the adaptation for different hardware devices to ensure the stability and reliability of the system. Through continuous technological innovation and optimization, the performance and application value of artificial intelligence swimming teaching model are continuously improved, and finally the traditional teaching methods are effectively supplemented and upgraded, bringing a better teaching experience to the majority of students.

4. Application case analysis

4.1 Research objects and methods

Participants: 68 freshmen majoring in navigation in Dalian Maritime University in 2023 (34 in the control class and 34 in the experimental class). Research methods: literature, questionnaire and experiment. Conduct pre-test and post-test, and use SPSS13.0 statistical software for mathematical statistics. Among them, literature method is a scientific research method, which involves collecting, analyzing and evaluating all kinds of literature to acquire knowledge or explain phenomena. This method is very important in various disciplines, because it provides researchers with a solid foundation for previous research results, and can help build a theoretical framework, put forward research assumptions and guide experimental design.

The questionnaire survey method is a widely used method to collect research data. It asks questions to the respondents by designing questionnaires in order to obtain opinions and opinions on a certain phenomenon or problem. Experimental rule is another scientific inquiry method, which can discover or verify scientific conclusions through experimental operation, observation and record analysis under controlled conditions. It is an important means of modern biological research and one of the basic methods in many scientific research fields.

4.2 Results and Analysis

(1) Pre-test results of 50m breaststroke:

Table 1: Pre-test results of 50m breaststroke

GROUPS	NUMBERS	AVERAGE (%)	STANDARD DEVIATION
EXPERIMENTAL CLASS	34	14.48	2.32
CONTROL CLASS	34	14.56	2.26
P	>0.05		

As can be seen from Table 1, there is no significant difference in breaststroke performance between the two classes, and the basic situation is the same, which can be a comparable sample.

(2) Post-test results of 50m breaststroke:

Table 2: Post-test results of 50m breaststroke

GROUPS	NUMBERS	AVERAGE (%)	STANDARD DEVIATION
EXPERIMENTAL CLASS	34	45.38	9.32
CONTROL CLASS	34	31.53	12.34
P	<0.05		

The test results of students' learning ability evaluation scores in the experimental class and the control class are shown in Table 3:

Table 3: Test results of students' learning ability evaluation scores in experimental class and control class

INDEX	NUMBERS	MAXIMUM	MINIMUM VALUE	AVERAGE (%)	STANDARD DEVIATION	STANDARD ERROR	VARIABLE COEFFICIENT
EXPERIMENTAL CLASS	34	98	75	84.36	3.45	0.67	4.31
CONTROL CLASS	34	76	54	66.78	2.38	0.56	3.56
T	24.2574						
SIGNIFICANCE	P<0.001						

The results of t-test fully show that the artificial intelligence swimming teaching model can effectively improve students' learning ability compared with the traditional teaching model.

(3) The results and analysis of the exercise intention of the two groups of students after the experiment:

Table 4: Investigation results of students' swimming practice after teaching

	PRACTICE OFTEN	IDOL PRACTICE	NO PRACTICE	NUMBERS
EXPERIMENTAL CLASS	23	8	3	34
PERCENTAGE	67.65%	23.53%	8.82%	
CONTROL CLASS	7	13	14	34
PERCENTAGE	20.59%	38.24%	41.18%	

The results of the survey on whether students are willing to continue swimming after graduation are shown in Table 5:

Table 5: Investigation results of students' willingness to continue swimming after graduation

	VERY WILLING	WILLING	NOT NECESSARILY	UNWILLING	NUMBERS
EXPERIMENTAL CLASS	14	12	5	3	34
PERCENTAGE	41.18%	35.29%	14.71%	8.82%	
CONTROL CLASS	5	7	12	10	34
PERCENTAGE	14.71%	20.59%	35.29%	29.41%	

As can be seen from Tables 4 and 5, the artificial intelligence swimming teaching model can meet the needs of students, and it can improve students' interest in learning more than traditional teaching.

5. Conclusion

Through this paper, it can be concluded that the introduction of artificial intelligence technology can significantly improve the efficiency and quality of swimming teaching. Artificial intelligence technology can realize real-time capture, analysis and feedback of swimming movements, and help students quickly correct their mistakes and master correct swimming skills. In addition, artificial intelligence can also make personalized training plans according to students' physical fitness, technical level and learning progress, so as to improve the training effect. In addition, the application of deep learning algorithm in the teaching model of swimming skill training is of great significance. Through the deep learning algorithm, a large number of swimming action data can be studied and analyzed, and the key features of swimming skills can be extracted, so as to better guide students to train.

At the same time, the deep learning algorithm can also realize the automatic recognition and classification of swimming movements, providing a convenient tool for teaching. Therefore, the combination of artificial intelligence technology and swimming teaching is helpful to cultivate high-quality swimming talents. With the aid of artificial intelligence technology, students can master swimming skills more efficiently and improve their competitive level. At the same time, artificial intelligence technology can also provide students with personalized training suggestions to help them achieve excellent results in swimming competitions. To sum up, the research on the teaching model of swimming skill training in colleges and universities under the background of artificial intelligence provides new ideas and methods for swimming teaching. Through in-depth research and application of artificial intelligence technology, it is expected to promote the reform and development of swimming teaching and cultivate more outstanding swimming talents.

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