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5G Network-Aided Online Music Learning and Teaching System

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Abstract. With the rapid development of intelligent teaching systems, traditional teaching methods have gradually felt the convenience brought by computer aided teaching systems. Smart technology will lead to disruptive changes, and a new era of education is coming. Therefore, how to provide a music teaching system with high efficiency and intelligence is a problem that needs to be solved by technicians in this field. To address this problem, this paper investigates the construction of a computer aided music education teaching system based on a 5G communication system, which is implemented with the aid of the Radial Basis Function (RBF) algorithm. Research shows that the current music teaching method usually adopts on-site teaching, adopting one-to-many teaching model, teachers demonstrate the performance on the platform, students imitate the rehearsal in their seats. The computer aided system can also present a visual analysis report for each student, showing the learning and mastery, and propose subsequent improvement plans according to the ranking of the analysis results. In accordance with the premise of individualized students to develop scientific teaching programs, 5G communication system and RBF network can fully meet the learning needs of students, improve the teaching effect. Therefore, through the computer aided music education teaching system can well evaluate the quality of music teaching, further improve the teaching needs of students and the development of modern music education.

Keywords: Computer aided music education teaching system; 5G communication system; Radial basis function; Construction and application
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1 INTRODUCTION

In the traditional teaching environment, it is difficult to truly qualify teaching due to the lack of technical support, while intelligent teaching systems serve education and help inform the education system. In recent years, following the rapid development of artificial intelligence, a new teaching model has been reconstructed and a computer aided teaching system has been

established to transform the educational relationship from a traditional one dominated by teachers and students to a pluralistic one dominated by teachers, students, and networks. It helps to enrich teaching forms, improve teaching ability and level, and cultivate multifaceted composite talents [1].

The intelligent teaching model changes from a dual teaching subject dominated by teachers and students to a pluralistic relationship dominated by teachers, students, and networks, allowing the interaction between teaching and learning to develop in the direction of diversification, precision, and openness. The development of computer aided technology, the change of learning modes, and the adaptability and diversity of online learning resources have formed online and offline teaching activities that can freely and interchangeably realize teaching and learning interactions, significantly improving teaching effectiveness. From the three teaching links of pre-class preparation, classroom situation, and post-class review, computer aided teaching is better than traditional teaching in terms of teaching links, reflecting high efficiency and precision. Pre-lesson preparation means that teachers send learning requirements and learning content to students' clients through the Internet, and students learn and complete related tasks according to the requirements. The teacher's review of students' pre-class online pre-study reinforces important knowledge points for students and summarizes common problems. After-class review is the process of deepening consolidation and further deepening of classroom content. Intelligent technology performs big data analysis on the massive data sets of the teaching process and makes computer aided evaluations for each student.

Current university teachers have almost the same teaching methods, teaching styles, and lesson plans every year and have not broadened their knowledge and adapted their teaching content to the new environment in a timely manner. For students, the traditional teaching model uses uniformly prescribed teaching materials, individualized teaching, and the use of diverse teaching aids. For teachers, personalized teaching requires thousands of teaching materials and teaching methods to support, and the workload is quite complicated, which makes it very difficult to develop by teachers alone. Therefore, computer aided teaching systems are needed to analyze students' learning performances, study habits, and learning behaviors to match and push different teaching contents and teaching methods. When using the computer aided teaching system, teachers should first study the teaching materials carefully [2]. In the process of lesson preparation, the computer aided teaching system will first recommend matching lesson plans, teaching materials, and teaching methods to teachers according to the requirements of the course syllabus taught, so that teachers can learn advanced teaching ideas and use new teaching methods. Secondly, the computer aided teaching system can precisely push learning resources related to teaching and can select matching teaching resources for teachers and students adaptively to achieve one-to-one precise service improvement and perfection, providing rich materials and resources for teaching.

The computer aided teaching system breaks through the traditional teaching method in time, space, and geographical constraints to directly represent various things and phenomena and can show the whole process of the development of things in a short period of time so that students can get the fullest perception of the material they are learning. Students can hear and see as if they were there. At the same time, because music is an aural art, the expressive power of other integrated arts can help people understand and feel the image of music art.

Educational teaching activities generate a large amount of educational information, but teachers need limited time and energy to process this information, especially in the absence of individual student attention. Teaching governance that drives data analysis Most college teachers conduct teaching activities based on experience, and whether this empirical teaching model can be fully transformed into a teaching model that combines experience and data analysis requires a massive amount of data on the teaching process and needs to ensure that the data is usable and analyzable. A disruptive and computer aided technology is needed to create a circular flow of data in the process of teaching and learning, teaching and management. The step-by-step recording function of the sequencer allows you to record difficult examples in parts and then listen to the

harmonic effect of the four parts. This is very useful for the development of harmonic hearing and harmonic thinking by repeatedly listening to a strict four-part harmony. Teaching polyphony also has the disadvantage of lacking actual sound due to the difficulty of playing the examples, especially the examples of polyphonic counterpoint [3].

This study will discuss the theoretical underpinnings of artificial intelligence-based music education and evaluate its benefits over conventional music teaching techniques an effort to address the deficiencies of the current computer-aided music teaching education system. The RBF algorithm is specifically targeted to be used for teaching music through computer-aided systems, and the neural network model is analyzed at the same time. To better realize computer-aided music teaching, the training model and construction method of neural networks are taken into consideration.

2 RELATED WORKS

Ugli [4] studied the auxiliary projection method to design the teaching system and provide case studies. Sun [5] proposed a system resource allocation method based on power iteration, which realized the optimal allocation of vocal music teaching system with normal power through iterative optimization. Dehham [6] adopted quantitative research method to study the assisted teaching combining teaching technology and intelligent technology, which has achieved great success in the world.

Affected by the COVID-19 epidemic, the normal teaching process and teaching quality evaluation have been greatly affected. In order to ensure the quality of classroom teaching, Luo et al. [7] used BP neural network to build a teaching quality evaluation model. Based on the introduction of BP neural network model and teaching quality evaluation problem, the paper focuses on the teaching quality evaluation index and BP neural network algorithm and process. The use of artificial intelligence in education is known as artificial intelligence education. There are numerous AI-powered applications in educational institutions. Sun et al. [8] applied artificial intelligence modules and knowledge recommendation to the teaching system to create an online learning system. Intelligent teaching methods are useful for examining the potential internal relationships between evaluation outcomes and different variables. The system can help students increase learning efficiency and make learning content more focused, according to the system's final test application.

In recent years, computer aided music education teaching system has been widely used in the field of music education. The advantages of high speed and low delay of 5G communication system can bring a lot of convenience to the application of computer aided music education system. First of all, the high speed of 5G communication system can greatly improve the data transmission speed of music education and teaching system, making the teaching process more smooth. To sum up, the application of 5G communication system in computer-aided music education and teaching system has great potential and advantages, which can bring better teaching effect and practical experience for music education and teaching. Therefore, this paper focuses on the application of 5G communication system in computer aided music education and teaching system.

3 MODELING METHODS

3.1 5G Communication System

The fifth-generation mobile communication system (5G) is the next generation of mobile communication technology after the 5G mobile communication system. Compared to 5G, the network transmission rate of 5G mobile communication technology will be increased by nearly 100 times, and the network delay will be reduced from milliseconds to microseconds. At present, some governments and industry sectors at home and abroad have already started planning for the

construction of 5G mobile communication systems [9]. Figure 1 shows the satellite communication in 5G.

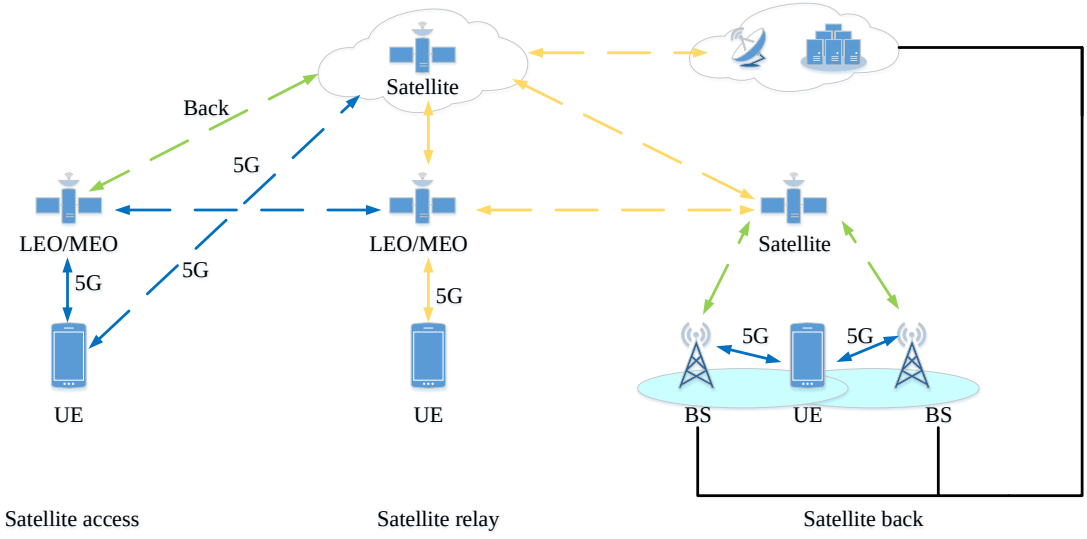

Figure 1: The satellite communication in 5G.

With the commercial deployment of fifth-generation mobile communications, more and more organizations and stakeholders are beginning to investigate next-generation mobile communications systems. This paper discusses the physical layer communication technology, network architecture and network intelligence, and analyses and introduces some key technology candidates to deepen the understanding of 5G communication systems and conduct related research work. Currently, 5G networks are being vigorously developed, and countries around the world regard 5G as one of the new driving forces for social development, and are competing to deploy 5G networks and develop new 5G services. Although 5G is still in the initial stages of commercialization and the technology is yet to be enhanced, it is necessary to simultaneously anticipate the communication needs of the future information society and initiate research into 5G technologies.

With the development of communication technologies, changes in network architecture and network intelligence, 5G communication systems will play an important role in human life, industrialization and applications in various industries. This paper introduces a number of key technologies for 5G in different dimensions, including physical layer communication technologies, network architectures, and network intelligence applications, in order to deepen the understanding of 5G communication systems and carry out related research work. The most radical model of convergence is full convergence, i.e. complete senseless interfacing, from the networking to the airports. A simpler form would be for the networks to develop independently of each other, complete with multi-system support through multi-mode terminals.

3.2 RBF Neural Network Introduction

The development of an intelligent teaching system for music education based on the 5G communication system and its application with the aid of the RBF algorithm is being researched, which helps to improve students' capacity for inquiry and also gives the teacher a leadership position [10].

A single hidden layer feed-forward neural network with locally tuned neurons and the RBF method uses a radial basis function as the activation function for the hidden layer neurons. An output layer that is a linear combination of the hidden layer neurons' outputs are the main components of the algorithmic model used to build the computer aided music education teaching system, as shown in Figure 2.

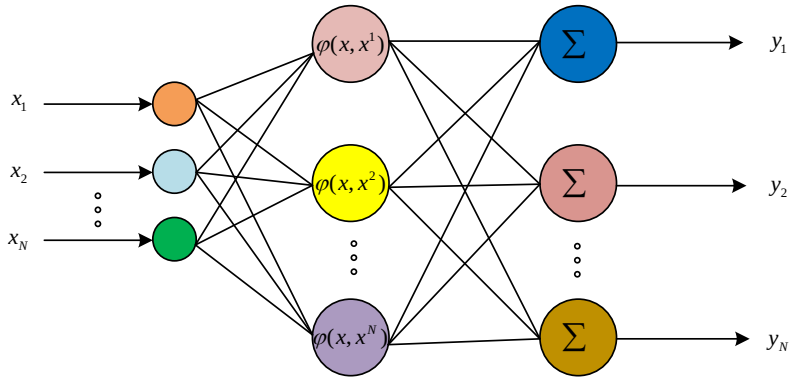

Figure 2: Schematic diagram of the RBF network model.

Next, the training principle of the RBF network is further explained. We derive the entire training process of the RBF network based on the general form [11]. The Gaussian kernel function is defined as follows:

$$\varphi(x_i, c_i) = e^{-\frac{\|x_i - c_i\|^2}{2\sigma^2}} \tag{1}$$

where c_i is the centroid of the jth neuron, σ is the width of the Gaussian kernel, and $\| x_i - c_i \|$ is the Euclidean distance from sample x_i to centroid c_j.

The RBF network is defined as follows:

$$f(x) = \sum_{j=1}^{q} w_j \varphi(x, c_j) \tag{2}$$

where W_j is the weight of the jth neuron.

We define the error function as the mean square error and the objective is to minimize the error function:

$$E = \frac{1}{2m} \sum_{i=1}^{m} e_i^2 = \frac{1}{2m} \sum_{i=1}^{m} (f(x) - y)^2 \tag{3}$$

Further simplification of the above equation gives:

$$E = \frac{1}{2m} \sum_{i=1}^{m} (\sum_{j=1}^{q} w_j \varphi(x, c_j) - y)^2 \tag{4}$$

We use the BP algorithm to back-propagate the errors and use gradient descent to find the direction of the RBF network parameter optimization respectively. Linear weights of neurons in the output layer:

$$\Delta w = \frac{\partial E}{\partial w} = \frac{1}{m}\sum_{i=1}^{m}(f(x)-y)\varphi(x,c) = \frac{1}{m}\sum_{i=1}^{m} e_i \varphi(x,c) \tag{5}$$

The parameter gradient update formula is:

$$w_{k+1} = w_k - \eta \Delta w \tag{6}$$

The centroids of the neurons in the hidden layer are denoted as:

$$\Delta c_j = \frac{\partial E}{\partial c_j} = \frac{\partial E}{\partial \varphi(x,c_j)} \frac{\partial \varphi(x,c_j)}{\partial c_j} \tag{7}$$

The partial derivative function is obtained:

$$\Delta c_j = \frac{1}{\mathrm{m}}\sum_{i=1}^{m}(f(x)-y) w \frac{\partial \varphi(x,c_j)}{\partial c_j} \tag{8}$$

Bringing the parameters into the above equation gives:

$$\Delta c_j = \frac{1}{\mathrm{m}}\sum_{i=1}^{m}(f(x)-y) w \varphi(x,c_j) \frac{x-c_j}{\sigma_j^2} \tag{9}$$

Further simplification yields the neuron centroids of the hidden layer:

$$\Delta c_j = \frac{1}{\mathrm{m}}\sum_{i=1}^{m}(f(x)-y) w \varphi(x,c_j)(x-c_j) \tag{10}$$

The parameter gradient update formula is:

$$\mathrm{c}_{k+1} = c_k - \eta \Delta c \tag{11}$$

The width of the Gaussian kernel of the implied layer is denoted as:

$$\Delta c_j = \frac{\partial E}{\partial c_j} = \frac{\partial E}{\partial \varphi(x,c_j)} \frac{\partial \varphi(x,c_j)}{\partial c_j} = \frac{1}{\mathrm{m}}\sum_{i=1}^{m}(f(x)-y) w \frac{\partial \varphi(x-c_j)}{\sigma_j^2} \tag{12}$$

Further derivation gives:

$$\Delta \sigma_j = \frac{1}{\mathrm{m}\sigma_j^3}\sum_{i=1}^{m}(f(x)-y) w \varphi(x,c_j) \left\| x_i - c_i \right\|^2 \tag{13}$$

The parameter gradient update formula is:

$$\sigma_{k+1} = \sigma_k - \eta \Delta \sigma \tag{14}$$

For each parameter in the RBF, we choose a different learning rate, and we continue training until the error function converges after a number of iterations. The centroid of each Gaussian kernel is treated as a parameter to be iterated over in this case, as opposed to being randomly chosen or clustered, to ensure that the iterated centroids are more suitable for the total data format. First, RBF networks are less complex than BP networks, typically consisting of a single hidden layer; second, RBF input terms are translated into a high dimensional space using a Gaussian transformation; third, RBF networks typically outperform BP networks in terms of their capacity for function approximation and rate of convergence. Throughout the design process, the software platform is continuously updated until a flawless model is created. Figure 3 depicts the programming diagram for it.

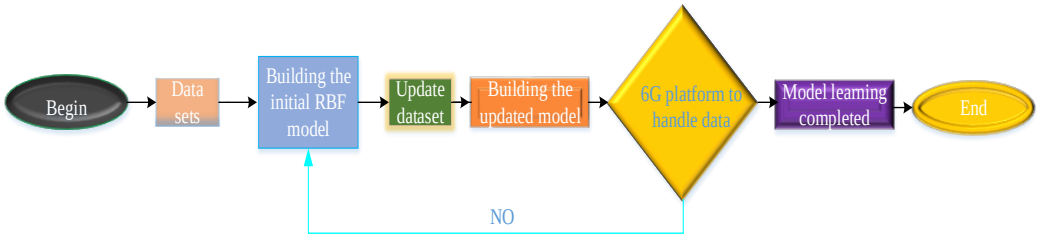

Figure 3: 5G-based computer aided teaching system building program design flow chart.

3.3 Analysis of the Construction of a Computer-Aided Music Education Teaching System based on 5G Communication System

Computer aided teaching based on the 5G communication system can improve education methods, levels, and creative outcomes, and will become a powerful support and supplement to modern education and teaching. Through the computer aided system's research on intelligent teaching modes, intelligent lesson preparation, intelligent teaching, intelligent customization, and big data analysis of students' processes before, during, and after learning, teachers can accurately understand each student's learning interests and style and other information, and make personalized teaching programs in a targeted manner, thus achieving good educational results. Based on this, the current situation and problems of artificial intelligence in education and teaching are discussed and suggestions are made.

The scientific selection of teaching resources and the construction of a teaching framework, the relevant knowledge points combined with the accurate recommendation mechanism in big data into different categories, according to different categories of clustering discrete analysis, and finally to accurately recommend to students learning video sort for the computer aided platform. Students can use smart devices for mobile learning, project participation, promoting thinking and problem solving to a certain extent. The learning content recommended by the smart platform enables students to use smart devices for mobile learning, project participation, promote thinking and problem solving, and to some extent enhance students' thinking and innovation abilities. Teachers focus on knowledge points, use existing video information, and have much less workload and more free time to think carefully about possible problems in the teaching and learning process, and to analyze and solve problems in depth. Students and teachers have online roundtable discussions through the smart platform, where the teacher throws out tasks and students can express their own opinions, while the teacher then makes comments to consolidate mastered knowledge and innovative ideas. 5G communication system platform contains the model of the pedagogue and the model of the learner, reflecting all the contents of the teaching system development and giving it timely feedback to learners, forming a good teaching loop, as shown in Figure 4.

4 DISCUSSION AND ANALYSIS OF RESULTS

Computer aided music teaching based on the 5G communication system provides music learners with better learning concepts. It can enhance education methods, levels and creative outcomes, and will become a powerful support and supplement to modern education and teaching. Through the computer aided system's research on intelligent teaching modes, intelligent lesson preparation, intelligent teaching and intelligent customization, and big data analysis of students' processes before, during and after lessons and customized learning, teachers can accurately understand each student's learning interests and style and other information, and develop personalized teaching programs in a targeted manner, thus achieving good educational results. Based on this, the current

situation and problems of AI in education and teaching are discussed and suggestions are made. Figure 5 compares the actual effect ratings of traditional teaching, classical intelligent teaching, and computer aided teaching based on 5G among students. The computer aided music teaching based on the 5G communication system is significantly better than the traditional teaching method and slightly better than the classical teaching method, further illustrating the effectiveness of the system build.

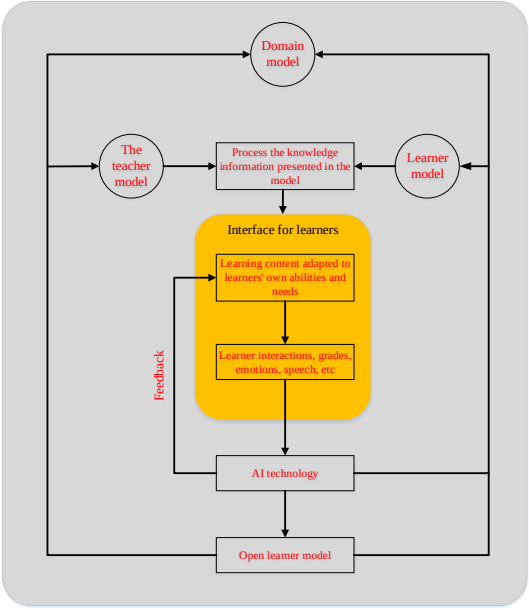

Figure 4: Interactive Learning Loop Diagram.

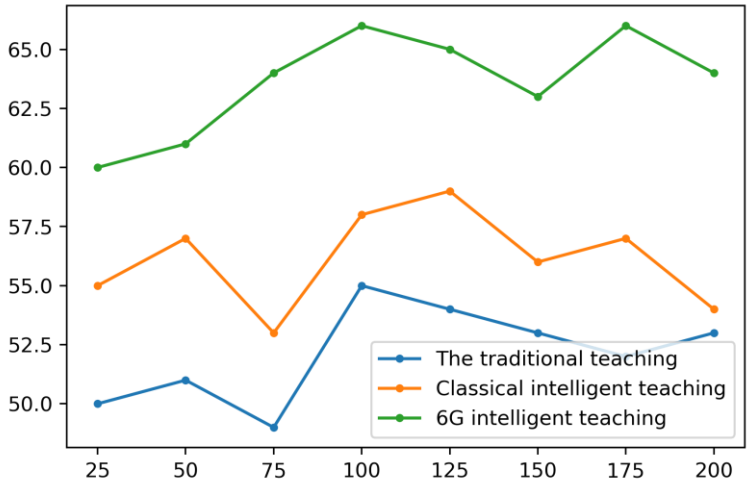

Figure 5: The satisfaction comparison of different teaching methods.

The traditional teaching method of teachers focusing on knowledge points and using existing video information reduces the workload considerably, leaving more free time to think carefully about possible problems in the teaching and learning process, and to analyze and solve them in depth. Students and teachers engage in online round-table discussions via the Smart Platform, where the teacher throws out tasks and students can express their own opinions, while the teacher then comments on them, consolidating mastery and innovative ideas. This helps to increase student enthusiasm and participation, enhance the autonomy of deepen the emotional interaction between teachers and students. Figure 6 visualizes the fluctuating assessment data for the traditional teaching model, which is volatile and unstable and not sufficient to illustrate the effectiveness of the traditional teaching model.

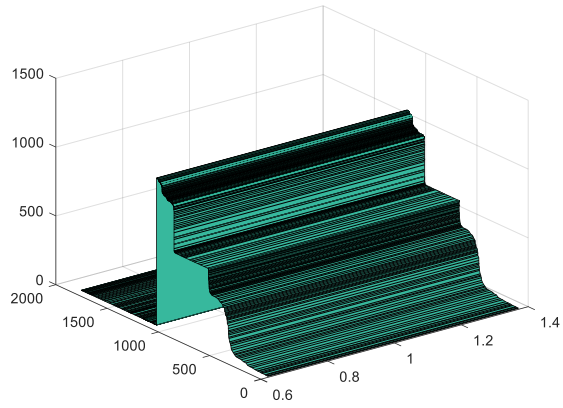

Figure 6: Visualization of evaluation data fluctuation in traditional teaching mode.

Classic Smart Learning Smart learning is a student-centered learning behavior carried out in an intelligent teaching system. Students not only have timely access to learning resources, course assessments and feedback on their performance, but also support personalized learning needs, making learning more efficient, easy and fun. Figure 7 visualizes the fluctuating assessment data for the classic computer aided learning model, which is volatile and unstable and not sufficient to illustrate the effectiveness of the classic computer aided learning model.

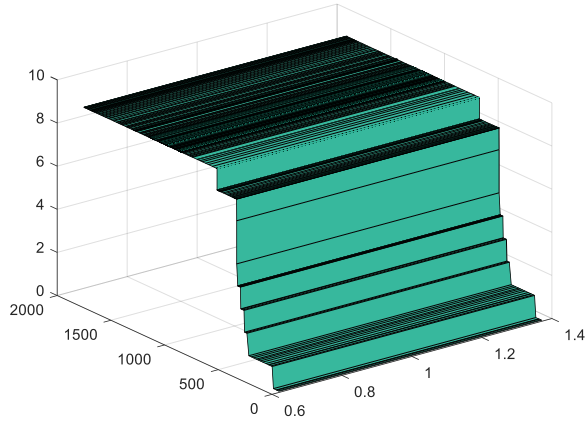

Figure 7: Visualization of evaluation data fluctuation of classical computer aided teaching model.

Computer aided teaching based on the 5G communication system can scientifically select teaching resources and build a teaching framework, and combine relevant knowledge points with the accurate recommendation mechanism in big data to classify them into different categories, and carry out cluster discrete analysis according to different categories, and finally recommend learning videos to students accurately. problem solving and to a certain extent enhance students' thinking and innovation skills. Figure 8 visualizes the fluctuations in assessment data for the computer aided teaching model based on the 5G communication system. The overall fluctuations are small, the assessment effect is stable, the data is reliable and has a greater advantage over the two teaching models mentioned above.

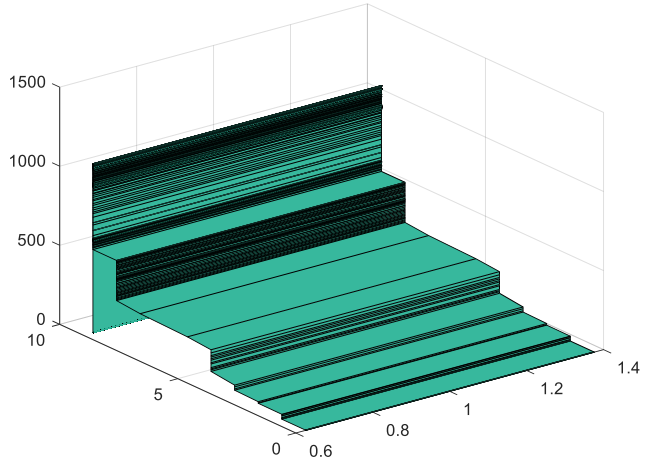

Figure 8: Visualization of evaluation data fluctuation of computer aided teaching mode based on 5G communication system.

5 CONCLUSIONS

Through this research, we find that 5G communication system has important application value in computer aided music education and teaching system. It can improve the teaching efficiency, improve the learning experience of learners, improve the teaching quality, improve the teaching effect, and can effectively improve the teaching environment. Therefore, 5G communication system has important application value in computer aided music education and teaching system, worthy of further research and promotion. 5G communication system has significant advantages in computer aided music education teaching system, such as improving teaching efficiency, improving learners' learning experience, improving teaching quality, improving teaching effect and so on. In the future, the development direction of 5G communication system in computer-aided music education and teaching system can be more application scenarios, more technical support, more data analysis, and more intelligent functions.

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