

<sup>1</sup> Xueying Liu  
<sup>1</sup> Ke Ma  
<sup>2</sup> Yuting Dong\*

# Analysing The Development of Web-Based Multimedia Piano Playing Teaching Design Using Multiple Linear Regression Algorithm



**Abstract:** - The popularity of piano lessons has increased recently, and many individuals are taking the instrument. Using Web technology as its backbone and high-performance streaming media technology, this platform for teaching piano playing can efficiently address the issues of a limited audience, a steep learning curve, and a shortage of available materials in today's online education landscape. This kind of instruction may help bring the classroom closer together. The goals of this study are to increase the effectiveness of communicating via online text, to make it easier for students to get expert guidance from teachers, to satisfy students' interest in learning, to elevate students' piano effectiveness and creation, and to promote the widespread use of the piano. Using a Multiple Linear Regression Algorithm (MLRA), this study makes recommendations for designing an intelligent piano-playing teaching system, looks into the implementation of the piano-teaching system, and offers a technique to evaluate piano-playing using the MLRA model for the difficulties of online piano training. Teaching the piano is greatly aided by this paper's portrayal of an instructor encouraging students to keep up with their practice. The study results stated that MLRA's recognition accuracy is 95% and its mean square error rate is 12%.

**Keywords:** Multiple Linear Regression Algorithm (MLRA), piano playing, web technology, theory, practice.

## Research Highlights

- Many people are taking piano lessons these days, and the instrument's popularity has skyrocketed.
- By leveraging high-performance streaming video technology and the Internet as its foundation, this platform for teaching piano playing may effectively tackle the challenges of a small audience, a challenging learning curve, and a lack of resources in the current state of online education. The students in this class might end up becoming closer as a result of this kind of lesson.
- The study's objectives are to improve online text communication, facilitate student-teacher expert guidance, pique students' interest in learning, boost students' piano skills and creativity, and encourage more people to play the piano.
- This study recommends an intelligent piano-playing teaching system, investigates its implementation, and offers a technique to evaluate piano-playing using the MLRA model for the difficulties of online piano training. It uses a Multiple Linear Regression Algorithm (MLRA).
- The research found that MLRA has a 12% mean square error rate and a 95% recognition accuracy.

## INTRODUCTION

The different parts of playing the piano, including techniques, theories, ears training, vision, and repertory, should all be covered in a curriculum that has been carefully crafted and planned out. Building a solid foundation of abilities students may utilize to advance their piano playing should be a primary focus in the curriculum. The organization of piano instruction is another crucial component [1]. The piano performance major is part of the initial classification of instrumental music education. This type of instrumental music education focuses primarily on teaching students to master the piano as a solo instrument, as part of an ensemble, and as an accompaniment, and it also includes specialized instruction in areas such as knowledge base, keyboard and pedal skills, musical performances and style preferences shaping and development. Its comprehensive teaching method and style of instruction incorporate its scientificity and pragmatism, and it also displays the bottleneck preventing the further growth of piano education. China's history, culture, and national identity are all reflected in very different ways in the country's Western music compared to the music of China's people. Inevitably, the teaching and growth of piano music would eventually become incorporated into the culture of Chinese national music, therefore displaying a particular federal music style [2]. From the beginning, the teaching method and concepts have been based on the paradigm of Western piano instruction, and they have been completely standardized and systematic [3].

Educational program configuration professionals offered a specialized review along the progression of the piano courses. These specialists used instruction that made use of the word processor that was available in the learning environment. These aspects of remote education brought further improvement in a new type of learning. To decide on the concept of online classes, they need to modify the significant capability of instruction practice and the

<sup>1</sup>Minjiang University, Tsai Chi-Kun Academy of Music, Fuzhou, Fujian, China, 350108

<sup>2</sup>School of Music, University of Queensland, Brisbane, Australia, 4072

E-mail: 1728@mju.edu.cn (Y.D.)

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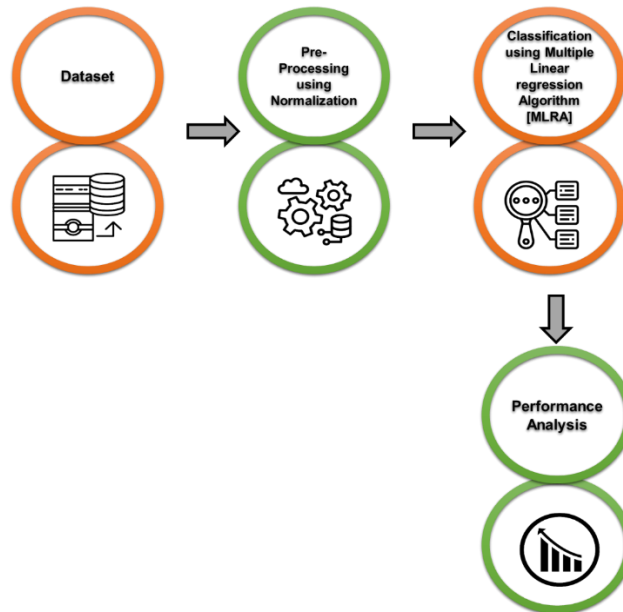
online learning educator's interactive learning educator and learn to train for a linear distant education system [4] [5]. The music's dynamics, pace, and emotion may be controlled by a talented pianist by their touch and through the use of the pedals positioned at the bottom of the piano [6]. The current generation uses technology that links lone learners and collaborative learning styles to interact, work, and study. Technology-based teaching methods for music should include both individual and group learning tools. A web-based learning environment provides a cutting-edge casual setting for people with various musical backgrounds to study and practice music [7]. By analyzing the issues in web-based multimedia piano-playing teaching design, we propose a Multiple Linear Regression Algorithm (MLRA) approaches to resolving it.

The paper [8] focused on detailing how technology is used in piano teaching at a university in North Cyprus, as reported by 18 student music instructors, to show further the teaching of music has been upgraded with the use of technology to provide suggestions for additional advancements. The research used a questionnaire with both closed-ended questions examined numerically and open-ended questions assessed depending on content analysis. The methodology for this study was referred to as a mixed-methods study. The study [9] proposed a recurrent neural network (RNN)-based music teaching resource construction, method, and application. Accomplish this by Concentrating on the requirements of music distance learning and analyzing the user role requirements of teachers, students, and system administrators. The paper [10] investigated the ways in which one may learn music via the use of a web-based learning environment. Users of a web-based learning environment were given the task of doing a self-assessment of their progress in the study of music. This investigation aimed to identify the kinds of educational experiences students had while using the Internet to study music in a virtual classroom setting. The research [11] analyzed the current state of music education in colleges and universities. They will offer some unique insights and suggestions in this article. Citations to relevant literature and academic studies will support these. The use of a mobile intelligent terminal to study the material presented in university classes has developed into a more powerful technological feature due to the rising use of the Android platform and the growing popularity of mobile intelligent terminal devices. The paper [12] presented that computer teaching is a one-way transmission of information without contact; this presents challenges in the form of a neural network model for grading piano playing. This paradox may be resolved by using computer-based multimedia software in the context of piano instruction. This approach has recently become more practical. The study [13] compared complex and complicated network and multimedia technology to piano teaching instances to categorize, analyze, study, and assess these instances, eliminate the unimportant and keep the important, and screen out some typical teaching instances that meet current learning theories, teaching requirements, and the features of the piano discipline. Technology in multimedia and networks, especially multimedia technology, supports the new teaching methodology. The paper [14] enhanced the standard of piano instruction; the Multimedia-based Piano Teaching Model (MPTM) is presented as a potential solution in this piece of research. The use of multimedia technology allows for the improvement and expansion of conventional piano teaching in this study. The education model used for assessing instructors is based on the Internet, and the methodical technique that represents teaching the piano incorporates a variety of various music educational resources.

The study [15] discussed the process of building multimedia-based interactive learning media for piano practice in the form of interactive films and the efficacy of such learning media. The demonstration in the interactive video is given at a slower speed, making it more straightforward to follow throughout the learning process. Based on these figures, the researcher anticipates multimedia-based interactive videos to be an accessible replacement for piano practice for everybody. The paper [16] regulated teaching rhythm, stimulated students' appetite for information, and enriched piano instruction materials using multimedia technology. A questionnaire determines most high-efficiency students' attitudes toward online piano teaching using multimedia technology. The research [17] expanded on whether information and communication technologies, including multimedia, are used in projects and knowledge and skill management elements. The experimental study's outcomes and implementation of online learning courses for enhancing prospective music instructors' proficiency in instrumental performance are discussed.

## II. PROPOSED METHODOLOGY

Due to the difficulties in evaluating the problem of piano music for teaching purposes and the limitations of current teaching difficulty processing algorithms, a new, more effective approach is given here. During processing, data from various sources is gathered and analyzed to determine the operational level of the issue. Data normalization is a preprocessing method for reducing the variation in a dataset's values. Using this for musical scores or other data associated with a part of music's effectiveness might be helpful during the process of piano teaching. In this research, we propose a Multiple Linear Regression Algorithm (MLRA) for creating an intelligent piano-playing education platform. Figure 1 can recognize the conceptual development of our study.



**Figure 1: MLRA flow diagram**

### A. Dataset

From Nanjing Xiaozhuang University in China, 150 students participated in the research. This study used an observation with a control group as the pre-and post-test. There were significant increases in Pedagogical Knowledge (PK) from 206.72 to 304.40, Technological Pedagogical Knowledge (TPK) from 259.75 to 272.50, Pedagogical Content Knowledge (PCK) from 271.00 to 295.00, and Technological Pedagogical Content Knowledge (TPCK) from 261.00 to 295.00 among students in the TPACK test, which was considerable  $p < 0.05$ . The difference in results between the experimental and control groups on the Piano Lesson Achievement Test experimental group: 293, control group: 174 were declared statistically significant  $z = 2.67$ .

PK, which contributes to the TPACK model. The term PK describes a set of competencies educators possess in curriculum, assessment, and instructional practices. TPK is a subset of the broader TPACK paradigm that defines what educators need to know about using technology in the classroom. Nonetheless, tests or evaluations could check how well pupils can utilize technology for education. TPACK is a framework for describing that educators must know to make good use of technology in the classroom.

### B. Data preprocessing

When working with musical performance or analytic data, the data pretreatment method of normalization might be helpful for piano teachers. Normalization's purpose is to simplify evaluating and interpreting datasets by standardizing their value range.

Using the lowest and maximum values in a dataset, min-max normalization may be used for online piano instruction to normalize the variables from 0 to 1. Regardless of the specific gear or software used for the on-demand piano instruction over the web, this may be especially helpful when working with data that spans an extensive range of values or units of measurement.

To normalize data to a range from 0 to 1, as in the case of a web-based piano instructor analyzing a student's performance, Min-Max normalization may be used. The equation (1) for Min-Max normalization is like this:

$$x_{normalized} = (x - x_{min}) / (x_{max} - x_{min}) \quad (1)$$

Where  $x$  = original data value; for example, a student's playing accuracy;

$x_{min}$  = minimum value in the dataset;

For example, a student's lowest playing accuracy value; and

$x_{max}$  = maximum value in the dataset

e.g., the maximum accuracy value in the dataset.

After the numbers have been normalized, the instructor may evaluate the student's growth throughout many online classes. The instructor can see where the pupil has progressed and where further work is needed. Min-Max normalization is simply one of many possible normalizing methods for use in online piano instruction; this method depends on the nature of the data being analyzed and the desired outcomes of the study.

### C. Classification using multiple linear regression algorithm

Multiple linear regressions can be a useful statistical tool in piano teaching to help understand how different factors contribute to a student's performance. It entails doing an investigation into the connection that exists between several independent factors and a single dependent variable. For instance, a piano instructor may use multiple linear regressions to investigate how a student's performance on a particular piece of music is influenced by characteristics like the amount of time spent practicing, their age, and their degree of expertise. The instructor

may gather data on both the independent and dependent variables (for example, the degree to which the student's efficiency is accurate) and then use multiple linear regressions to analyze the links between the two sets of variables. The following is equation (2) for numerous linear regressions:

$$y = b_0 + b_1x_1 + b_2x_2 + \dots + b_nx_n \quad (2)$$

In this equation,  $y$  stands for the dependent variable, such as the degree to which the student was successful,  $x_1, x_2, \dots, x_n$  stands for the independent variables, such as the amount of practice time, age, and experience level, and  $b_0, b_1, b_2, \dots, b_n$  stands for the coefficients that are associated with each of the independent variables. The instructor may use the findings of the multiple linear regression analysis to determine which independent factors have a substantial influence on the dependent variable, as well as how those variables contribute to the student's overall performance. This information may be put to use in the development of more efficient teaching tactics and in the process of adapting the curriculum to the specific requirements of each student. It is essential to remember that multiple linear regressions are only one of many statistical techniques that may be used in piano instruction. The investigation's unique circumstances and objectives will determine the tool utilized. Furthermore, the accuracy of the findings and their practical application will be contingent on the quality of the data gathered and the suitable selection of independent variables. Multiple linear regressions for piano teaching are shown in Algorithm 1.

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#### Algorithm 1: Multi-linear regression

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**Step 1:** Provide the input parameters:

- $x_1$ : Average weekly time spent practicing
- $x_2$ : Years spent practicing the piano
- $x_3$ : Student's Age
- $x_4$ : Student's Gender (0 for male, 1 for female)

**Step 2:** Provide the output parameters:

- $y$ : The extent to which one is skilled at the piano

**Step 3:** Obtain  $(x_1, x_2, x_3, x_4, y)$  tuples for the algorithm's training data.

**Step 4:** To verify that everything is being measured on the same scale, normalize the input variables. The algorithm should reach a solution more quickly now.

**Step 5:** Separate the data sets used for training into training and validation. Around 80% of the data should be used as the training set, while the remaining 20% should be used as the testing dataset.

**Step 6:** Use the data from the training set to teach the model. The method seeks the coefficients that result in the smallest sum of squared deviations between the anticipated and observed values.

**Step 7:** Use the validation set to assess the model's efficacy. This will show if the model is challenging to find or underfitting the data.

**Step 8:** Once trained and verified, the model may predict a learner's competency level.

**Step 9:** Show the student their estimated level of expertise, individualized comments, and suggestions for enhancing their piano playing.

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### III.RESULT AND DISCUSSION

Consequently, the efficacy of web based makes it simpler for students to acquire qualified assistance from instructors, satiate students' desire to study, raise students' piano effectiveness and creativity, and encourage the broad usage of the piano. The creation of an intelligent piano-playing training method is suggested in this study using an MLRA. The efficiency and accuracy of a proposed method are compared to those of ways such as support vector machines (SVM) [19], back propagation neural networks (BPNN) [20], and multiple signal classification (MSC) algorithms with artificial intelligence (AI) [21] to show the effectiveness of the method. These techniques are compared with previous techniques using several criteria, including accuracy, Latency, power, time, and mean square error.

#### 1. Accuracy

Throughout this instance, accuracy would be the capacity of the web-based multimedia piano-playing instructional design to successfully communicate the desired educational material utilizing correct and trustworthy data, approaches, and directions.

$$Accuracy(\%) = \frac{TP+TN}{TP+FP+FN+TN} (\%) \quad (3)$$

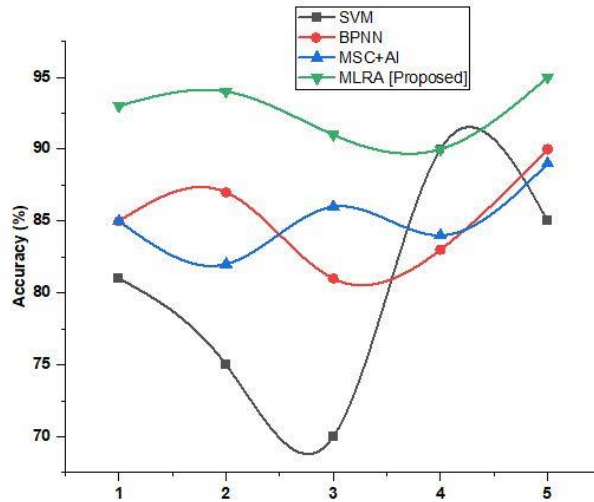


Figure 2: Accuracy

Table 1: Accuracy

Accuracy (%)				
METHOD	SVM	BPNN	MSC+AI	MLRA [Proposed]
1	81	85	85	93
2	75	87	82	94
3	70	81	86	91
4	90	83	84	90
5	85	90	89	95

Figure 2 shows the accuracy of the proposed and existing system. The Accuracy of the proposed MLRA has been suggested for creating an intelligent piano-playing training method. It shows that the proposed approach has more accuracy than the existing one. Table 1 depicts the values of accuracy.

2. **Time**

The duration of a web-based multimedia piano-playing instructional design is defined as the time needed to complete it and achieve the desired learning results. The equation for time is:

$$t = d/v \tag{4}$$

Where t is time, d is distance, and v is velocity.

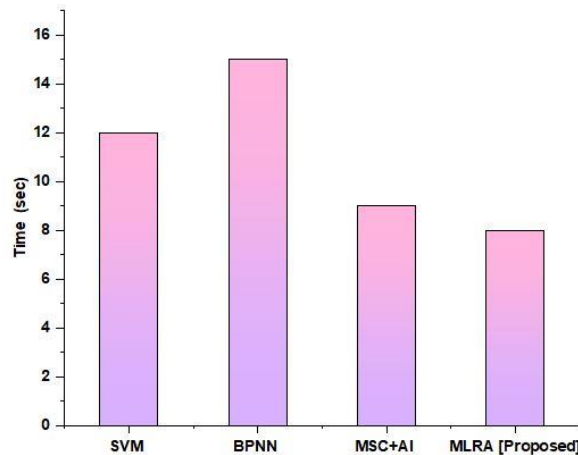


Figure 3: Time

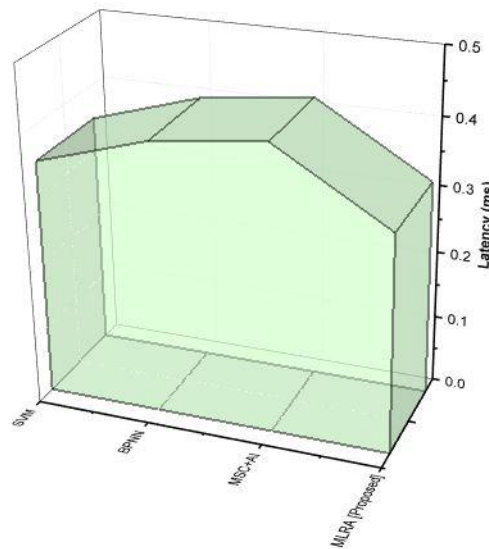
**Table 2: Time**

METHOD	Time (sec)
SVM	12
BPNN	15
MSC+AI	9
MLRA [Proposed]	8

Figure 3 shows the time of the proposed and existing system. The time of the proposed MLRA has been suggested for creating an intelligent piano-playing training method. SVM has attained 12 (sec), BPNN has achieved 15 (sec), and MSC + AI has completed 9 (sec), whereas the proposed system reached 8 (sec) of time. It shows that the proposed approach has less time than the existing one. Table 2 depicts the values of the time.

3. **Latency**

The term latency describes the time interval between a user's input and the system's response. Latency, in the context of web-based multimedia piano-playing education design, refers to the gap between the user pushing a key on their keyboard and the system producing the appropriate sound.



**Figure 4: Latency**

**Table 3: Latency**

METHOD	Latency (ms)
SVM	0.35
BPNN	0.4
MSC+AI	0.42
MLRA [Proposed]	0.32

Figure 4 shows the Latency of the proposed and existing system. The Latency of the proposed MLRA has been suggested to create an intelligent piano-playing training method. SVM has attained 0.35 (ms), BPNN has achieved 0.4 (ms), and MSC + AI has achieved 0.42 (ms), whereas the proposed system reaches 0.32 (ms) of Latency. It shows that the proposed approach has less Latency than the existing one. Table 3 depicts the values of Latency.

4. **Power**

Power is a system's capacity to process and provide excellent audio and visual outputs. Power is crucial to a web-based multimedia piano instruction design since it guarantees users a high-quality and engaging learning experience. The equation for power is:

$$Power = work/Time \tag{5}$$

Where power is measured in watts (W), work is measured in joules (J), and time is measured in seconds (s).

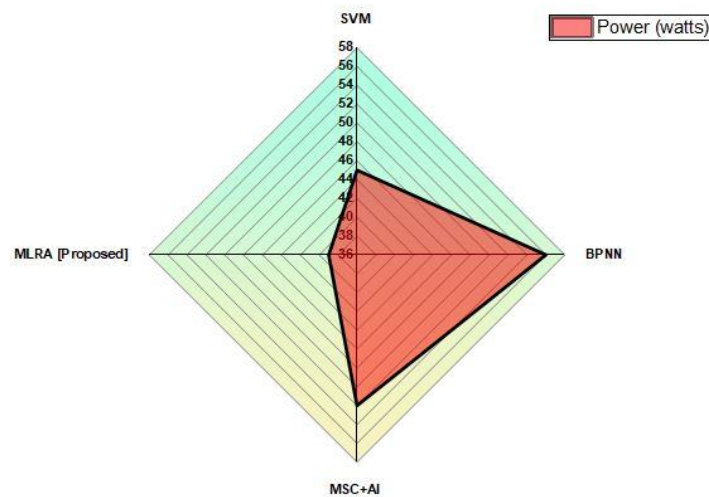


Figure 5: Power

Table 4: Power

METHOD	Power (watts)
SVM	45
BPNN	56
MSC+AI	52
MLRA [Proposed]	39

Figure 5 shows the Power of the proposed and existing system. The Power of the proposed MLRA has been suggested to create an intelligent piano-playing training method. SVM has attained 45(watts), BPNN has achieved 56(watts), and MSC + AI has completed 52(watts), whereas the proposed system reaches 39(watts) of Power. It shows that the proposed approach has less Power than the existing one. Table 4 depicts the values of Power.

5. **Mean square error**

MSE is a statistical metric that expresses the discrepancy between a variable's expected and actual values. MSE is a technique that may be used to assess the precision of a system's piano sound reproduction in the context of a web-based multimedia piano-playing education design.

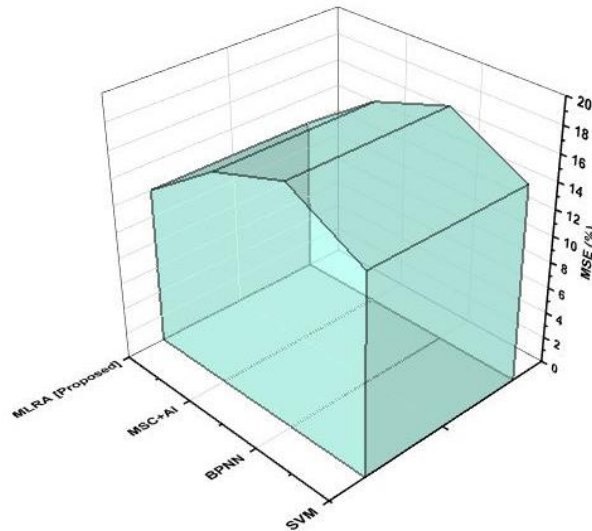
The equation for mean square error (MSE) is:

$$MSE = \sqrt{\frac{1}{n} \sum_{i=1}^n (I_{Pi} - I_i)^2} \tag{6}$$

Where:

n is the total number of samples or observations

$p_i$  is the actual or observed value of the  $i^{th}$  sample or observation



**Figure 6: Mean square error**

**Table 5: Mean square error**

METHOD	MSE (%)
SVM	15
BPNN	18
MSC+AI	16
MLRA [Proposed]	12

Figure 6 shows the Mean square error of the proposed and existing system. The MSE of the proposed MLRA has been suggested to create an intelligent piano-playing training method. SVM has attained 15%, BPNN has achieved 18%, MSC + AI has gained 16%, whereas the proposed system reaches 12% of MSE. It shows that the proposed approach has less Mean square error than the existing one. Table 5 depicts the values of Mean square error.

**IV.CONCLUSION**

In conclusion, web-based multimedia piano training presents many advantages and possibilities for both piano instructors and their students. Teachers may enhance their student’s learning experiences and results using modern digital tools and web-based resources. This study suggests the creation of an intelligent piano teaching system using a Multiple Linear Regression Algorithm (MLRA), and it explores the implementation approach of such a system. We calculate that MLRA has a mean square error rate of 12% and a recognition accuracy of 95%. The benefits of web-based multimedia piano teachings are undeniable; even so, there are also some difficulties associated with them, including the need to guarantee consistent and high-quality audio and video, the need to provide clear and concise instructions and feedback, and the need to strike a balance between the use of technology and more traditional teaching methods. Further study might be done to evaluate the efficacy of multimedia teaching techniques, like interactive exercises or online games, compared to more conventional pedagogical approaches.

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