Education Mode Reform of Colleges and Universities in Music Teaching under 5G Internet

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Research Article

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Abstract: A research focusing on the education mode reform of colleges and universities in music teaching under 5G Internet is carried out to better apply 5G (5th generation mobile networks) Internet technology into the education. At first, advantages of 5G Internet are illustrated. Then it introduces characteristics of education informalization. Finally, it combines 5G Internet technology and education perfectly to design concrete scene of 5G in the educative application and conclude innovative application of 5G application in the education. Results suggest, on the basis of 5G Internet technology, education methods of colleges and universities in music teaching have been getting diversified. Especially on the current colleges and universities music class situation, colleges and universities music education puts music culture and music literacy together and deepens the verified exploration on education mode. Teachers on multimedia class extend diversified contents of music education. They gradually present different styles and ideas of music to student, which makes development of music education in broadness and depth and transforms traditional methods of music education. It will be a kind of joy for student to study it on class, which makes them consider more paths to study music. In this way, students can associate music with society development and add their music knowledge to more diversified music contents. In the meantime, application of music-thinking mode in multi-ethnic music learning, overall multi-culture music thinking, improvement of music literacy and enhancement of music culture soft power can be achieved.

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1. Introduction

Under 5G, in order to improve quality and efficiency of teaching, breaking-through of traditional teaching methods and modes shall be achieved to lead current teaching. It meets up with the need with solving problems in teaching process, broadens eyesight of students and forges their ability of thinking. In this way, innovative talents can be trained. Not only can they get knowledge on class, but they can adapt to society developing fast. In the present stage, the main problems faced China’s music education are making students enthusiastic with music, improving effects of teaching and enhancing teaching quality. Research results suggest, efficient network information technology shall be used to break through traditional teaching mode. Only effective and lasting measures being adopted to solve the problems in current teaching process, can music teaching be developed and
innovated. Transforming traditional teaching mode is just a method to enhance quality of music teaching and to enhance music literacy of people. Its final point and purpose are to change traditional idea of music teaching and to improve overall music culture literacy of people [1].

By introducing 5G, enriching education mode colleges and universities in music teaching with adaptive information technology and exploring better ways in which information technology and music teaching mode can combine, and the objective is to find the brand-new modern teaching mode focusing on teaching quality, art evaluating and music literacy. The new teaching mode can give birth to a fantastic chemistry mixture of modern music and traditional music, enrich teaching mode abundantly, make students more active and interested with the music class so they can enjoy learning in fun. More comprehensive music talents can be trained, music literacy of student can be enhanced and overall nature of people can be improved, which promotes society development in harmony and propels all the culture industries of society to move forward [2].

Through basic introducing of 5G and innovative application in education, research of colleges and universities teaching mode under 5G is made. 5G industry chains involve a lot of industries among which the Internet and communication count the most. 5G application tends to communication basically. But innovation and development of 5G application seldom appear in education research and novel development as well as advanced application of 5G technology in teaching mode are in urgent need. 5G music teaching research is an epitome of smart education propelled by 5G. Break-through of limits in traditional education can be achieved by better combination of technology and education through 5G. This improves both interests of students and efficiency of teaching. Broadening education practice, management and policy maker should cooperate and take participants in innovative teaching propelled by 5G. They should work on how to propel and accelerate effective application of information technology in the education management mechanism. In this way, limits of traditional education can be erased and new goals of education modernization can be achieved. Focusing on this purpose, reform and innovation of music teaching mode under 5G is researched. And deep exploration of how to realize upgrading and updating of teaching application optimization is made, which can be suggestion and reference for research on education and information technology combination in the future. The paper also can be referred by 5G development and innovation research.

2. Materials and Methods

2.1 Definition of 5G network

5G network is the newest generation of mobile network technology in the world presently. Its advantages include fast data transmission, higher bandwidth, cost and energy saving. 5G has significant improvement of transmission speed compared with the older cellular network, namely about 100 times faster than 4G (The 4th Generation Mobile Communication Technology). The above are prominent advantages of 5G. For an example, downloading of a 1G (1st Generation Mobile Communication System) film can finish in 4 seconds under 5G network [3].

2.2 Related theoretical basis

Compared with traditional networks, advantages of 5G network are as follows:

(1) Faster transmission of 5G network

Compared with 4G, 5G has prominent improvement in transmission speed. Using 5G technology in data transmission can significantly reduce time cost, and improve work efficiency greatly.

(2) Stability of 5G network

There are advantages of 5G net communication technology in transmission stability as well. Application of 5G net communication technology can adapt to most kinds of complicated fields and perform transmission
function stably. Work efficiency of relative workers will be largely improved by 5G due to its stability in practical application [4].

3) High frequency transmission technology of 5G network

High frequency transmission technology is the core technology of 5G. With expanding need of 5G network communication technology in daily work, higher frequency transmission technology and higher bandwidth need to be developed to guarantee the operation of 5G. Figure 1 shows advantages of 5G network:

![Figure 1: advantages of 5G network](image)

According to history of world computer network development, 5G network building, technology standard, terminal tests and practical application are getting to perfection. Thus, kinds of industries have prepared to 5G’s arrival. 5G net technology breaks through communication between people. Now its business use has taken priority in world economic competition and will accelerate every development process of products in industry chains. The prime goal of 5G is to get approval and access of market, which can make 5G net communication technology develop and enhance in most extent [5].

It’s necessary for 5G to seize the opportunity and accelerate its business use under development of service in information era. Sooner the 5G is used in business way, faster it can be applied in real life scene. And it needs to be keeping optimized until mature. Problems appearing in 5G business use, such as application scenes and users’ experience, direct how to make improvement and optimization. Subject of application and consumer can participate in producing progress so that the level of 5G application can be finally improved [6].

2.3 The history of the 5G network

Modern 5G net development has experienced mobile communication technology reform time after time. Its history is as below:
In 1986, relying on the FDMA (Frequency Division Multiple Access) technology, 1G era arose. China carried out nine-year compulsory education system in that year and many people get access to education.

In 1995, saying farewell to 1G era, TDMA (Time Division Multiple Access) technology brought humankind into 2G (2-Generation Wireless Telephone Technology) era. On this moment, Reform and Opening started to accelerate. China began to vigorously develop education career, and both hardware and software of education had some promotion.

In 2007, with CDMA (Code Division Multiple Access) technology developing, 3G (3rd-Generation) network saw its popularity. Closely after that, education enterprise met its unprecedented huge changes. At this time, mobile online learning appeared and the development of distance education began to lunge.

In 2013, application of OFDMA (Orthogonal Frequency Division Multiple Access) technology gave birth to 4G. Era of mobile internet formally occurred. Smart phone seemed to be a part of people but television gradually faded out of people’s daily life. New educational companies and every kind of live platforms appeared one after another. The internet giants of China – BAT (Baidu, Alibaba and Tencent) three companies entered the market promptly. Holding the slogan “the Internet will finally subvert traditional education”, varieties of education entrepreneurs joined the business.

Nowadays, 5G rushed into people’s eyesight with 4G not thoroughly fading away. In most time, impact of technologies on business is gradual reform with slow pace. But it will be a great lap between 4G era to 5G era [7].

Since 2020, 5G were being located in China with high speed. Three giant telecommunication companies – China Telecom, China Mobile Communications Group Co., Ltd and China Netcom released their 5G building plan. Before those happened, 5G investment plans of 2020 went out from these three telecommunication companies. According to these plans, 500 thousand of 5G base stations would be built in 2020. Among them, 250 thousand of base stations would be built by China Mobile Communications Group Co., Ltd. In the meanwhile, about 250 thousand of base stations which cover all prefecture-level (including) and above cities in China would be built by China Telecom and China Netcom jointly. Figure 2 shows the 5G building plan of these three giant telecommunication companies.

<table>
<thead>
<tr>
<th>Operator</th>
<th>5G capital development</th>
<th>Number of 5G base stations</th>
<th>5G coverage</th>
<th>5G deployment method</th>
</tr>
</thead>
<tbody>
<tr>
<td>China Mobile</td>
<td>100 billion yuan</td>
<td>25000</td>
<td>Covering all cities at the prefecture level and above in the country</td>
<td>Accelerate the evolution to SA and adhere to the integrated development of cloud and network</td>
</tr>
<tr>
<td>China Telecom</td>
<td>100 billion yuan</td>
<td>25000</td>
<td>Covering all cities at the prefecture level and above in the country</td>
<td>5GSA’s commercial capabilities are in a leading position in the industry, and the integration of 5G + public cloud + MEC maximizes the value of 5G technology</td>
</tr>
<tr>
<td>China Unicom</td>
<td>100 billion yuan</td>
<td>25000</td>
<td>Covering all cities at the prefecture level and above in the country</td>
<td>Commercialized 5G SA network in mid-year, and promoted a high degree of synergy of “cloud and network side industry”</td>
</tr>
</tbody>
</table>

Figure 2: 5G building plan of these three giant telecommunication companies in 2020

2.4. Multiple Input Multiple Output (MIMO) technology
Multiple Input Multiple Output (MIMO) technology is gradually becoming the core technology in the communication industries, which is also one of the key technologies in the 5th generation mobile network. This technology also plays an important role in the reform of teaching mode under 5G network. Single-user MIMO (SU-MIMO) system is a point-to-point MIMO system (Point-to-Point MIMO). Multiple antennas are placed at the transmitter and receiver, respectively. Assuming that the single-user MIMO system has transmitting antenna root $N_t$ and receiving antenna root $N_r$, the signal received by the receiver can be described as:

$$y = \sqrt{p_u} Gx + n$$  \hspace{1cm} (1)

In equation (1):

$$x = [x_1, x_2, \ldots, x_{N_t}]^T$$  \hspace{1cm} (2)

The transmitting signal in equation (2) is a column vector of $N_t \times 1$ dimensions, in which $x_i$ represents the transmitting signal of the root antenna $i$.

$$n = [n_1, n_2, \ldots, n_{N_r}]^T$$  \hspace{1cm} (3)

Equation (3) is a column vector of $N_r \times 1$ dimensions, which represents the noise and interference in the signal transmission process. And $n_1, n_2, \ldots, n_{N_r}$ is an independent and identically distributed complex Gaussian random variable with mean of 0.

$$R_n = E[nn^H] = \frac{1}{N_r} I$$  \hspace{1cm} (4)

Equation (4) is the covariance matrix of noise, the user's transmission power is represented by $p_u$.

Assuming that a standard is made on the total power of the transmitted signal, then

$$E\left(PxP^2\right) = 1$$  \hspace{1cm} (5)

Channel matrix $G$ is a matrix of $N_t \times N_r$ dimensions, which can be expressed as:

$$G = \begin{pmatrix}
g_{11} & g_{12} & \ldots & g_{1N_t} 
g_{21} & g_{22} & \ldots & g_{2N_t} 
g_{N_r 1} & g_{N_r 2} & \ldots & g_{N_r N_t} 
\end{pmatrix}$$  \hspace{1cm} (6)
The element $g_{ij}$ represents the channel fading coefficient between the transmitting antenna $j$ and the receiving antenna $i$.

Assuming that the transmitted signals are independent and identically distributed complex Gaussian random variables, and the receiving end has ideal Channel State Information (CSI), the instantaneous achievable rate can be expressed as:

$$C = \log_2 \det \left( I + \frac{P_u}{N_t} GG^H \right) \text{bit/s/Hz}$$

When the transmission coefficient of the channel matrix is standardized, the upper and lower bounds of the channel capacity can be obtained by using the Yansen Inequality:

$$\left(1 + p_u N_r\right) \leq C \leq \min(N_t, N_r) \log_2 \left(1 + \frac{p_u \max(N_r, N_t)}{N_t}\right)$$

The actual achievable rate depends mainly on the numerical distribution of the elements of the matrix $GG^H$.

When the user is in the edge of the neighborhood, that is, when the signal-to-noise ratio (SNR) is low, there is a variety in the achievable rate in equation (9):

$$C = p_u Tr(GG^H) = \frac{p_u N}{N_t \ln 2}$$

Equation (9) shows that when the user is at the edge of the neighborhood, the achievable rate is independent of the number of transmit antennas $N_t$.

The development potential of Massive MIMO technology in improving data transmission speed and transmission reliability makes the technology a research hotspot of 5G mobile communication in recent years. The research on uplink signal detection algorithm of large-scale MIMO system is also an important research direction of signal processing technology of 5G baseband. With the continuous development of MIMO technology, 5G will further accelerate the reform of music education mode in colleges and universities, and promote the development and reform of education in the future, which is the driving force for the continuous innovation and development of education informatization in China.

2.5. Basic understanding of education information

From the perspective of education career development in China, advanced technologies as the most representative 5G will be the stable basis of education career construction during a long period in the future. In the meanwhile, new innovation that change the era will be developed. Educational informatization will keep moving forward and focus on the 5G from the society will continue increasing. Along with combination of 5G upgrading with educational developing and advancing, significant changes in development and perspective of education will occur. These things give a huge impact on the ever-lasting traditional education methods. With 5G net technology environment continuous upgrading and developing, varieties of smart educational
Information sharing and interaction will become more convenient. This means combination of factors during the teaching process can be realized and brand-new education methods as well as presentation forms of content can be structured. Educational service will be in an arm’s touch. Finally, an unprecedented education system will be formed.

Knowledge comes from practice, it’s the same in educational informatization. During practice, IT (Information Technology) development brings a prominent affection [8-10]. High speed communication network accelerates development of information industry. Cloud Computing plays a role in information industry competition. Organization methods of educational service are under reconstruction by Big Data, AI (Artificial Intelligence) and other intelligence net technology. All kinds of public educational service systems, are open to the society, leading to the collective intelligence direction. Cloud network integration will be the result of the development. Popularization of intelligent service provides convenience to immersive intelligent educational service.

According to the background description above, it’s anticipated that main characteristics of educational informatization construction at present and in the future include [11-12]:

(1) Educational information unlimited transmission. Data analyses provide enough support to realization of immersive intelligent education experience. Perception of environment and data collection make it possible to transmit data from one place to another, which break through limits of time, distance and media etc. [13].

(2) Educational resource and service will cooperate more intelligently. Based on the development of intelligent technology and communication environment, multi-mode connection and coordination of all kinds of educational operation will be effectively and conveniently achieved. Intelligent ability of coordination will be put into management training in educational field, educational service and other aspects to promote reconstruction of business process and innovate new service mode. Smart learning and development system will provide more professional and educational business to meet with the requirement of different individual [14].

(3) Strong promotion of education equity. High-grade educational resource and service can be integrated through mobile internet. Break-through and development of technology also make them accessible to the daily study. Successful application of IT technology realizes education equity in the real scene. All of these are due to the large education development in the information technology [15].

5G technology steadily guarantees educational technology informalization. AI, VR (Virtual Reality), Big Data and other advanced technology will lead education informalization in the future. 5G technology propels development and reform in education area greatly and brings a big move to educational informalization in the future. Combination of ultra-low latency and Big Internet of Things of 5G network environment with advanced IT technologies such as slice technique, MEC (Mobile Edge Computing) and AI is essential to development of brand-new smart school and class application [16].

WiFi network in school supports data network of the traditional classes. It’s Bluetooth and ZigBee who make network between things available. 5G smart class makes the best of technical advantages in 5G’s nature. By generalizing 5G with all hardware terminals, 5G smart class meets up with real educational requirement of users in school with better educational experience. Mainly because: (1) schools with integrated network don’t need to accommodate many kinds of network; (2) smart class equipped with ultra-high network bandwidth can bear high level picture effect; (3) higher speed or lower delay support smart class learning video to be recorded at anytime and anywhere [17].

3. Design planning of 5G technology in education applications

3.1 Demand scenario
Three main kinds of 5G technologies application scenes are brought out on ITU (International Telecommunication Union) [18]: eMBB (Enhanced Mobile Broadband). It has a high peak rate and it can meet up with the requirement of people who are often in a high speed trip or in an area with a large population; URLLC (Ultra Reliable & Low Latency Communication). It meets up with the requirement of ultra-high speed and ultra-low delay operation scenes; mMTC (Massive Machine Type Communication). It fulfils the need of low power dissipation, low cost and low flow rate of communication network in some operation scenes. Relying on the need of integrating 5G technology and education scientifically and technically, after research and exploration, requirement of 5G technology in educational operation scenes has been listed in Figure 3.

![Figure 3: Requirement scenes catalogue of education institution](image)

According to Figure 3, requirements of secondary and primary schools as well as education institution mainly lay on distance listening and evaluating class, distance interactive teaching and AI evaluating teaching effect. Requirements of training college and military college mainly lay on VR (Virtual Reality)/AR (Augmented Reality) teaching and smart school application of management. The requirements of ordinary universities mainly lay on AI evaluating teaching effect and smart school application of management.

### 3.2 Overall view

From the perspectives of teaching, teaching research and education management, a general viewgraph is designed about 5G’s effect on the modern education. Distance control teaching and VR/AR are the most scenes in the education area support. Distance listening and evaluating class and AI teaching effect evaluating are the most scenes in education research. 5G technology is primarily used in smart school management characterized by the Internet of Things in education management area. Figure 4 shows the general viewgraph of 5G internet technology educational informalization.
4. Results

There are prominent changes in traditional education forms, with PC (personal computer) used in the Internet. Varieties of online learning platform appear, so that internet learning resource are available to people at any time. People enjoy great convenience in their learning. Development and innovation of 5G network technology give learners a chance to get learning experience whenever as well as in real classroom by the Internet of Things and VR technology, which set them free from limits of wireless network and spaces. Technology makes learning always in an arm’s touch and novel. On the Internet, experts can communicate and learn with each other. Research of 5G technology in education area is fully carried out to combine education industry and 5G technology reform intimately. The main idea of the research is explore the impact and effect of 5G on the core business of education [19].

4.1 Remote interactive teaching

Compared to the others, 5G network technology makes online teaching available to laptop client and mobile application. It solves the inconvenience of distance communication of traditional teaching and makes lessons available to learners whenever, which provides powerful technology support to optimization of classroom for teachers and students. 5G application in the terminal equipment in distance teaching scenes makes traditional learning mode limits vanished to students of any place. In the meanwhile, teaching methods have
been seeing changes which are superior to traditional teaching methods. Figure 5 shows distance interactive teaching scenes based on 5G technology.

**Figure 5:** distance interactive teaching scenes based on 5G technology

### 4.2 Teaching based on VR/AR cloud platform

Relying on the advantages of 5G’s ultra-big bandwidth, ultra-high speed and ultra-low delay, VR/AR teaching application’s functioning, rendering and control on the “cloud” are realized by strong computing power of the “cloud”. Structure of edge cloud is designed to fulfill every application need of teaching. Users can set low-delay mode on the edge near to them. Thus, the awkward problems such as low speed of internet and high delay of cloud service can be thoroughly solved.

VR/AR cloud platform fitted with communication should be made. Application of the new technologies such as the cloud and VR/AR/MR (Mediated Reality) can make teaching scenes in real classroom abundant. These technologies also make online virtual classroom more immersive, interactive and experiencing. Use VR to realize experiential teaching, and let students have in lessons. Transforming knowledge into virtual things that students can watch and interact with makes them totally placed in the real space to comprehend and feel the knowledge. As a result, students can learn knowledge in every aspect scientifically [20]. Figure 6 shows VR/AR teaching scenes based on 5G internet technology.
VR K12 Smart Education Resource Cloud Platform combines technologies such as VR technology and the Internet with teaching to develop and innovate education information technology, effectively propelling education reform. Figure 7 shows how it realizes the construction of a digitalized, modern and permanent education platform.
Compared to traditional education, education based on VR/AR cloud platform is characterized with: (1) that class experience of students arises from 2D (two dimensional) to 3D (three dimensional). As a result, the abstract knowledge can be shown in a digital figure and easier for students to understand and comprehend so that they can feel three dimensions better; (2) subjectively interacting learning, in which students can pause, repeat or continue the class by their will. This non-sequence or circling learning mode is good for students and won’t do harm to teaching; (3) gaming learning, through which teaching materials of much fun can be carried out in visualized and interactive VR/AR classes. Students can enjoy learning in the process; (4) distance teaching by VR/AR. Students and teachers from several different places can join in a class together. They can interact with others on the spot. Thus, sharing of the education resource and education equity can be realized; (5) decreasing possible teaching accidents. For an example, using AR/VR technologies to virtualize experiment can reduce security risks of doing physics or chemistry experiments in laboratories or classrooms [21].

4.3 AI evaluation of teaching process

AI application is the direction of the education development in the future. AI cameras can be set in classrooms to collect visual information and judge the facial direction of students to examine whether students listen carefully or not. Through monitors, teachers know if students are working hard and give hints or warning
accordingly. A focus degree of individual and whole class learning can be concluded by the collected data, where an auto focus degree data analyzing model is necessary. In conclusion, student management of school can be strengthened, under the integration of 5G technology and education management. AI technology has certain security risks in science teaching area, which should be given enough attention. Figure 8 shows scenes of AI evaluating application in teaching [22].

![Figure 8: scenes of AI evaluating application in teaching](image)

### 4.4 Smart campus management

Smart and intelligent school management primarily covers public facilities intelligent management of school [23]. Equipment such as cameras and sensors can collect information of school environment, students, teachers and other stuffs. Intelligent research can be made against the massive data by the Internet of Things and intelligent sensors. Using the results of research in the teaching and management service can realize real-time monitoring, properties management, environment monitoring, security monitoring, energy management and etc. Then the intelligent monitoring and operation of school can be guaranteed. Figure 9 shows smart school management based on the 5G internet.
5G bearer network

- mMTC network slice
- Other slices...

Safe campus equipment management

- Electronic access control, attendance machine, camera,

Smart campus management platform

- Electronic whiteboard, multimedia teaching all-in-one machine, projector

Smart sockets, smart street lights, infrared detectors, etc.

**Figure 9:** smart school management based on the 5G internet

5G smart and intelligent school management has several advantages as follows: enhancing information flow conversion degree, structuring informalization environment and intelligent management of equipment; realizing communication between electronic educational equipment and different platforms; realizing direct local management and indirect distance management; data collecting and management optimizing; secularly collecting equipment operation data and deeply analyzing them, besides, optimizing intelligent monitoring and management standard to achieve the goal of improvement effect of school management [24].

In these few years, China firmly propels informalized intelligent management development of school and smart education develops a lot. The market scale of China’s smart school industry has been expanding, which breaks through 20 billion yuan in 2012 and achieves 62.1 billion yuan in 2018. It’s estimated to be beyond hundreds of billion yuan in 2020. Figure 10 shows the market scale of smart school in China.
Figure 10: the market scale of smart school in China

5. Conclusion

With development of the Internet, Big Data and gradual application of AI, a reform of education mode from the traditional one to the smart one occurs. An education informalization era arises from now. 5G internet communication technology characterized with ultra-big bandwidth and stability can be applied in the online education even modern education construction. The research of colleges and universities music teaching mode reform under 5G internet is made, combining documentary research and investigation analyses. The research emphasizes on general application of 5G technology in modern education area. At first, this research illustrates main characteristics of education informalization. Then it proposes concrete requirement scenes and innovative application of internet technology in education. Finally, the research forms a general viewgraph of education informalization based on 5G internet communication technology. 5G technology will keep innovating, developing and leading upgrading in the future. Its innovation and application will give more deep contents into education scenes continuously and massively to propel development and reform of future education. 5G technology will be a native motion to keep China’s education informalization innovative and moving forward. More contributions will be made from multi-angle about 5G’s impact on education. Conversation here is about merely an application of 5G in the colleges and universities music education.
ETHICS APPROVAL AND CONSENT TO PARTICIPATE: NOT APPLICABLE.
FUNDING: NOT APPLICABLE.
CONFLICT OF INTERESTS: THE AUTHORS DECLARE THAT THEY HAVE NO CONFLICT OF INTERESTS.
INFORMED CONSENT: NOT APPLICABLE
AUTHORS’ CONTRIBUTIONS: ALL AUTHORS DISCUSSED THE RESULTS AND IMPLICATIONS AND COMMENTED ON THE MANUSCRIPT AT ALL STAGES. ALL AUTHORS READ AND APPROVED THE FINAL MANUSCRIPT FOR PUBLICATION.

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