

Feasibility Study of Applying 5G Mobile Communication Network Remote Visual Teaching Mode to Online Courses for Deaf Children

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Abstract. In the teaching of deaf children, the effective use of visual interactive network teaching can make more deaf children experience high-quality teaching experience and reduce the burden on families. However, the visual teaching technology also puts forward higher requirements for the network. The traditional network is difficult to support directly, and can not meet the access needs anytime and anywhere. By analyzing the characteristics of 5G network and visualization technology, this paper determines the advantages of 5G as the basic technology of visualization teaching network. With the support of 5G network, it can bring a new educational model to the teaching of deaf children.

Keywords: 5G · XR · Visual Teaching · Courses of Deaf Children

1 Introduction

In the teaching of deaf children, the effective use of visual means to carry out visual teaching can express the teaching content more intuitively through visual language according to the cognitive characteristics of students, so as to improve the learning efficiency and effect [1]. In the past teaching activities, online teaching was only used as an auxiliary means of traditional offline teaching. Especially for the rehabilitation learning of special children, face-to-face teaching between teachers and students was still the most important teaching mode. In particular, the emergence and spread of the epidemic makes online teaching implementation, teaching management, students' learning adaptability and acceptance face new challenges at the same time. With the development of 5G technology, new forces have been injected into the field of education. The expansion of teaching space and teacher teaching mode has provided new opportunities for online teaching for special children. The barriers between traditional teaching experience and new network teaching have been gradually broken. The new visual interaction mode has the space and possibility to implement.

2 Analysis of Rehabilitation Needs of Deaf Children and Visual Teaching Model

2.1 Current Situation and Needs of Rehabilitation Teaching for Deaf Children

At present, the rehabilitation education of hearing impairment in China is mainly through the way that the rehabilitation center for deaf children, public schools for the deaf, or ordinary kindergartens are equipped with language training classes for deaf children [2]. Some private schools also try to integrate deaf children into ordinary classes. In early education, more emphasis is placed on the form and content of language training. The role of family education is not prominent, and there is a lack of effective teaching means, resulting in a considerable number of regular students returning to special schools. In terms of the rehabilitation teaching needs of deaf children, the targeted design of curriculum content is very important. Teachers need to deeply understand the status of students, including the damaged parts, the degree of damage, and learning characteristics. Secondly, it is necessary to enhance the interactivity, observe the students' status in sensory training, oral training and sign language training in real time, and adjust the teaching methods and communication methods according to the students' status. These requirements put forward higher requirements for special education teachers. However, at this stage, domestic professional teachers are still scarce. There are a large number of deaf children who fail to enter formal rehabilitation centers for training [3]. At the same time, affected by the epidemic, the situation that they are unable to learn on site is more prominent. There is an urgent need to promote visual and interactive distance teaching through technical means, so that deaf children's rehabilitation learning can get rid of space constraints, improve the popularity and teaching efficiency of deaf children's rehabilitation teaching, and realize the optimal allocation of educational resources.

2.2 Title Investigation and Results of Network Teaching for Deaf Children

In network teaching, deaf children are the main body of learning. Therefore, the questionnaire survey and result analysis of online teaching on users is a necessary research process to ensure the smooth development and effective implementation of teaching. According to the survey of the rehabilitation center for deaf children of Tianjin disabled persons' Federation, 52.2% of deaf children wear cochlear implants, 29.3% wear hearing aids, and 18.3% wear two kinds of equipment at the same time. Among the deaf teachers surveyed, 58.8% prefer to combine classroom teaching with online courses, and 11.7% think that only online courses can be used in deaf children's teaching. The proportions of the two cases among students' parents are 36 and 4.5% respectively. In the setting of online courses, 74.3% of students (parents) chose online video interactive teaching and 23.8% recorded teaching videos. In the teaching effect, 96% of parents were satisfied with the teachers' online teaching preparation, and 47% thought that the online situation limited the teaching effect. Among the most favorite teaching aids for deaf children in online courses, 68.8% are physical teaching aids, 49.5% are video animation, 45.8% are self-made teaching aids, 19.2% are plane cards, and 16.5% are ppt. It can be seen from the survey results that the key in the rehabilitation teaching of deaf children is how to improve the ability and stability of the network and provide a more realistic interactive



Fig. 1. 6 Different degrees of freedom for a user in extended realities

teaching scene. Through enhancing visual effect, compensating sound effect and transmitting feedback in real time, better teaching effect can be achieved. Therefore, there is a more urgent need for network and visual teaching technology.

2.3 Online Visual Teaching Technology

At present, the demand for general teaching and rehabilitation for special groups continues to increase [4]. In order to enable more deaf children to receive high-quality teaching services, reduce family burden, and reflect the basic fairness and simple care between people, the visual online teaching method accessed through the Internet has been widely used [5]. From the initial simple realization of visualization, it has gradually developed into a high-definition, three-dimensional, real-time and multi-dimensional system. The main options are HD video (4k/8k), AR, VR, Mr, and even metauniverse, which have been used or tried in the course. Compared with the traditional flat display of online video teaching, the new video technology can provide a more real experience [6]. Taking 6DOF VR as an example, users can freely watch program materials at any position and in any direction in the physical space. It makes user walks through 3D 360 VR content displayed on an HMD freely.

Visual teaching technology not only provides better teaching experience, but also puts forward great demand for the network. Compared with the previous network applications based on personal surfing, online visual teaching is more demanding in terms of network speed, time delay and stability indicators. With the improvement of interactive experience of visualization technology, higher network speed and lower delay are required. Through the upgrading of network bandwidth and WiFi equipment, it is relatively easy to solve the problem at the fixed location indoors [7]. In the field of mobile communication, 4G technology has been unable to achieve free access and teaching. In urgent need of better mobile communication technology, break the restrictions of time and teaching space, free deaf children from a single screen terminal, build the learning situation required by deaf children with the help of hardware facilities, improve the knowledge system around their cognitive status through scientific and perfect rehabilitation content design, control the feedback of rehabilitation effect and parents' comprehensive evaluation of the course, and maintain the continuity of rehabilitation guidance. Therefore, the combination of visual interactive technology and 5G is an inevitable trend. By using the wide area 5G



Fig. 2. User Plane marking for QoS Flows and mapping to 5G Resources

coverage and slicing and other network isolation technologies, families of deaf children in remote or poor areas can also participate in more smooth and clear online teaching and enjoy a higher degree of freedom to receive education. The development in this field not only improves the quality of online teaching and expands the coverage of demand market, but also helps more deaf children transcend spatial boundaries Enjoy the positive results of teaching students according to their aptitude and integrated education.

3 5G Network and Visual Interactive Teaching

3.1 Support of 5G Network Key Technology for Visual Teaching

According to the roadmap of national education informatization development defined by UNESCO (United Nations Educational, scientific and Cultural Organization), education field has entered the integration stage. The management of informatization in teaching has been significantly improved, digital high-quality resources are widely shared, and the network infrastructure is fully covered. In the field of distance interactive teaching, various special technologies are gradually realizing integration and in-depth application. At the same time, it is in urgent need of the support of network infrastructure for highquality teaching to solve the obstacles caused by cost and network quality, and 5G is the key to solve the problems. As the latest generation of mobile communication technology, 5G has the characteristics of high rate, large connection, -low delay, etc. it has great advantages in the fields of visualization, remoteness, mobility and so on. It can create a network base for 4k/8k ultra video, XR remote cooperation and AI intelligent video. On this basis, 5G network slicing technology can allocate higher-level QoS flows for interactive teaching services, so as to obtain higher RB resources and support the network rate required by visualization technology. The 5G System is assumed to be based on QoS Flows, which is the finest granularity in the PDU Session. The principle for classification and marking of User Plane traffic and mapping of QoS Flows to AN resources is illustrated in Fig. 2.

At present, the educational field is gradually changing to intelligent education, and a new era of educational informatization has been opened. In addition to paying full attention to people, education, students and other aspects, smart education is increasingly making use of new generation information technologies such as cloud, big data, Internet, IOT, artificial intelligence and so on to create a new model of intelligent, perceptual and ubiquitous education. 5G operators or teaching service providers set up edge computing platforms in addition to conventional application servers to support the improvement of the processing speed of various interactive teaching contents, so as to obtain a higher experience of visual teaching and improve the teaching effect and students' feelings.

3.2 Typical Application of Visual Teaching for Deaf Children Based on 5G Network

In 2019, the white paper on equality, participation and sharing: 70 years of protection of the rights and interests of people with disabilities in New China issued by the State Council emphasized the key advantages of visualization technology in helping hearing-impaired children share the three-dimensional light and shadow learning field in the era of picture reading and promoting the integrated education of hearing-impaired children [8]. In specific teaching practice, visual teaching is often restricted by many practical technical means, the most prominent of which is the impact of network transmission[9]. With the arrival of 5G era, the mobile network can fully support the needs of visual teaching in terms of speed, delay and capacity, and create a better sense of immersion, interactivity and imagery. Through the efficient use of 5G network, a variety of visual applications can be used and carried out in the teaching of deaf children.

3.2.1 5G Multi-point HD Video Teaching

High definition video is the basis of visual teaching. High quality audio and video communication and multimedia cooperation can realize real-time communication between teachers and students, and provide clearer teaching content display for learners and professors. Multi point HD video can show more content details, so that students can make more full use of visual senses. Teachers can also observe more student feedback, and fully shorten the distance between teachers and students. With the basic coverage of 5G network, teaching can be realized anytime and anywhere. For deaf children, on-site teaching can provide far more experience than the classroom, and provide better teaching quality in terms of information and sensory touch.

3.2.2 5G + XR Teaching

XR technology is the general name of VR, AR, Mr and other technologies. Through the virtual and lifelike application scenarios of XR technology, we can realize the immersive situational teaching mode, create the course into a vivid and highly sensitive virtual scene, make the students' classroom experience jump from 2D to 3D, experience the immersive classroom effect, and put the theory into practice, so as to quickly improve the learning efficiency. XR immersive situational teaching can truly restore the abstract and difficult knowledge points of various disciplines, concretize the abstract concepts in

Use cases	DL bitrates (Mbps)	UL bitrates (Mbps)	One-way latency (ms)
FHD	10–20	-	20–70
4K	50-100	_	15–50
8K	100–150	_	15–50
AR	2–60	2–20	5-50
VR	30–100	< 2	5–20

Table 1. Typical visualization application network index requirements



Fig. 3. Simplified Architecture for XR end-to-end services

the macro and micro scenes, and visualize the difficult knowledge points. As the most popular multimedia teaching means at present, XR technology has high requirements for technical support. Table 1 lists the requirements of several typical visualization applications in network key indicators. 5G network can fully meet these technical requirements. At the same time, slicing technology can also provide better resource guarantee.

In the 5G network, in addition to the original embB enhanced mobile broadband and urllc ultra reliable low delay communication technologies, the newly frozen R17 version has studied and defined various types of XR, including AR, VR and cloud games, and defined requirements and evaluation methods for the identified XR traffic types. Figure 3 shows the service architecture of 5G XR under the typical architecture. When the user XR server is located in the external DN or trusted DN, the XR device can be regarded as 5G UE.

3.2.3 5G + Holographic Interactive Teaching

Holographic projection technique, also known as virtual image formation technique, is a technique for recording and reproducing the real three-dimensional image of an object by using interference and diffraction principles. Holographic projection technique can not only generate plane ground illusion, but also enable the illusion to interact with the performers, so as to realize the performance all the way and produce shocking performance results. Compared with the XR technology mode, the full range projection technology can get rid of peripherals such as glasses or helmets, fully release the learners' senses and realize real immersive. The three-dimensional holographic projection of teachers or teaching content can appear around students, so that students can



Fig. 4. 5G Edge Processing

more intuitively feel the teacher's explanation, further highlight students' focus, and obtain more teaching results. Compared with XR application, holographic technology has more strict requirements for network. The 5G R17 version brings enhanced features to some key technologies, including enhanced multi beam operation, enhanced multi Trp (transmitting and receiving points) deployment, enhanced eight antenna SRS (detection reference signal) triggering or switching, CSI (channel status information) measurement or reporting, etc. at the same time, it introduces richer spectrum resources, which makes the 5G network rate have room to be significantly improved. At the same time, in view of the time delay required by holographic images, a better time delay experience can be achieved through the combination of cloud service and edge computing. Figure 4 shows the process of cloud service and edge computing in 5G network.

4 Application of 5G Network Visual Teaching Mode in Online Courses for Deaf Children

According to the education informatization 2.0 action plan of the Ministry of education, education informatization should be based on emerging technologies such as artificial intelligence, big data and the Internet of things, rely on various intelligent devices and networks, actively carry out intelligent education innovation research and demonstration, promote the mode transformation and ecological reconstruction of Education under the support of new technologies, adapt to the development of 5G network technology, and meet the new requirements of intelligent learning that serves the whole time domain, the whole airspace and the whole audience, Focus on enhancing the efficiency and effect of knowledge transfer, ability training and quality improvement [12]. In the special field of education for deaf children, it is more necessary to make full use of 5G network technology and platform based special education system to realize a more efficient and inclusive online education model for deaf children. In the online course system for deaf children, 5G network can be used to realize the following visual teaching modes.

4.1 Innovative Teaching Interaction Mode

By building a national teaching platform for deaf children with key universities and hospitals as the core, we can enhance the cooperation of educational resources and help the intelligent development of education. Improve the comprehensive level of teachers through the class of famous teachers, make use of 5G technical ability, establish a network research and training community, invite famous teachers of famous schools to help and

improve targeted education in areas with weak educational resources, give full play to the characteristics of 5G ultra-high definition and low delay, create a multi screen interactive application terminal function concept display, realize holographic signal transmission, let teachers be in front of them, and comprehensively improve the classroom experience of children in class. At the same time, all kinds of IOT equipment are used to feed back the response information of students' reactions, expressions, physical status and so on in real time, fully support the medical attributes and needs of deaf children education, and form a ubiquitous learning framework that breaks the limitations of the physical environment.

4.2 Create Personalized Learning Mode

In the future, education will be more personalized and customized, so as to truly teach students in accordance with their aptitude. In the field of teaching deaf children, it is more necessary to adjust the teaching methods, progress and contents in real time according to the students' physical state, teaching response and even the working state of the manual access equipment. Personalized learning solutions rely on the joint efforts and cooperation of students, schools and education departments at all levels. With the addition of 5G mobile broadband, massive large connections and ultra-low delay, personalized learning solutions can build a customized knowledge and ability map for each student, focusing on the knowledge points they have mastered, have not mastered and need to be consolidated, as well as the comprehensive ability and quality assessment of health, sports and so on, Personalized push for students in combination with data calculation, and at the same time, combined with students' interests and hobbies and self-learning review and reflection, and create collaborative and enlightening learning modes in some subjects to give students more comprehensive learning programs.

4.3 Realize Intelligent Teaching and Management Mode

Different from the general teaching, the problem that needs to be faced up to and focused on in the education of deaf children is the imbalance of educational resources. It is more deliberate to ensure the fairness of teaching resources and the standardization of the teaching process. In order to avoid the psychological impact on deaf children caused by the selection of teaching content, teaching materials and teaching aids, teaching language and characters, it is necessary to form a set of effective teaching management system, and constantly standardize and improve the teaching methods. The 5G network and teaching platform are used to remotely access, monitor and analyze a variety of terminals, balance the use of resources, make the efficient and orderly use of various equipment, and realize the archiving, standardization and reminding of teachers' teaching process. While improving the learning mode, teaching mode, teachers' level and educational administration level, we should promote the implementation of fair and quality education.

5 Conclusion

In 2021, the Ministry of education and other six departments issued guidance on promoting the construction of new educational infrastructure and building a high-quality education support system, taking the emerging infrastructure of information network as the primary direction of new educational infrastructure, which is the driving force of educational reform in the information age and a strategic measure to accelerate the modernization of education and build an educational power. Therefore, we will promote and continue to build 5G smart education applied to online teaching for deaf children. First, we will promote the integration of 5G and high-definition video technology to provide deaf children with an online environment with more realistic experience and smoother interaction; Second, promote AI accurate evaluation, help teachers' high-quality research and training, carry out spatial linkage based on multi-level models such as individuals, classes and campuses, realize the interconnection of all things, create fine management, make deaf children, parents and teachers fully cooperate, make the teaching process of rehabilitation knowledge diversified and interesting, improve the teaching and rehabilitation effects, and provide sufficient and complete guarantee for promoting home school collaborative work.

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