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Visual Multimedia English Teaching Based on Network Security under the Background of Artificial Intelligence

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Abstract As times progress and develop, higher requirements have been put forward for students' moral education and English achievements. Visual multimedia has imperceptibly entered the English teaching classroom and provided the latest teaching methods and means in English teaching. Artificial intelligence (AI) technology can provide assistance for teachers in English teaching and reasonable training for students. It has objective feedback on English teaching and learning. The final average score of Class A with multimedia English teaching method based on AI was 79.5, which was 9.5 higher than that of Class B with traditional teaching method. Meanwhile, in order to better study visual multimedia English teaching, this paper designed a visual multimedia English teaching method based on network security, compared it with traditional teaching methods, and found that it can enhance students' English listening and speaking ability. The listening test scores of Class 1 using this research method were 5.5 points greater than those of Class 2 using traditional teaching methods, and the final test scores were also higher than those of Class 2, 10 points higher than the average scores of Class 2. Therefore, the research methods in this paper are valuable for the study of visual multimedia English teaching.

Index Terms Multimedia English Teaching, Multimedia Visualization, Network Security, Artificial Intelligence

I. Introduction

Along with advances in science and technology and the extensive use of computers, multimedia online English teaching has increasingly shown its advantages. Multimedia online English teaching methods are increasingly popular with all teachers and students. The new teaching method should make English teaching develop towards humanization and independent learning. The advantages of interactive and easy to operate multimedia network technology should be flexibly used, especially to the establishment of students' main influence in teaching [1], [2]. Therefore, a valid way to stimulate students' comprehensive ability to use language and characters is explored through visual multimedia English teaching in practice, so that multimedia teaching can fully use its unique role. Because of various reasons, there are many hidden dangers of network security, so the network teaching support platform also has such hidden dangers. The security of the network teaching support platform can directly affect whether the classroom teaching activities can be carried out normally, and its security problem is an imperative problem which should be solved. Due to the enlightening and political consciousness of the education platform, its security elements are ignored, which can lead to many bad consequences. Therefore, in the context of AI, the paper gave the security management framework and implementation suggestions for the visual multimedia classroom teaching support platform. According to the network security, the visual multimedia English teaching has achieved a better application effect, and the theme of this paper is of practical value.

With the popularization of English use, it is particularly important to make English learning better serve the public. The utilization of multimedia in English teaching is a result of teaching development. Many scholars have carried out in-depth research in this area. Dos Santos Luis M studied the use of visual video as an instructional tool in teaching strategies for English teaching in a community college in California, USA. The results showed that after a semester of English courses for English learners, both teachers and students expressed positive views on teaching strategies using social media learning platforms [3]. Kamelia Kamelia believed that video is an effective media, which can enable learners to enjoy the teaching and learning process more. Using video seems to offer a relaxed atmosphere for students to learn English. It can also make students more active and easy to understand materials, because videos contain images and sound, so that students can straight see the materials [4]. De Jager Lizette believed that the demand to advance English and incorporate social media into teaching in language has led teachers to devise novel teaching strategies that contain digital tools. The voice, actions and documents of teachers using social media were summarized and analyzed to devise teaching strategies which are suitable to teach English in social media platforms [5]. Shu Yang applied English translation to the utilization of computer

assisted multimedia teaching and created an authentic English learning context for students using multimedia-assisted teaching resources. The training of English translation in universities should be emphasized, so that students can really understand of the standard in English translation and grammar knowledge [6]. Few researchers have considered the visual multimedia English teaching research based on network security in the context of artificial intelligence. Therefore, it is meaningful to carry out multimedia teaching in English based on network security.

The purpose of AI research is to use computers to simulate human learning activities. Based on the network security in its context, it can help multimedia English teaching to be better realized. For this reason, many researcher have studied in detailed in this area, and related research reports are emerging in endlessly. Sun Zhuomin applied the AI module and knowledge suggestion to the system and developed an online system for teaching English compared with the ordinary teaching assistance system to advance English teaching efficiency for students in line with their knowledge mastery and personality and help teachers improve education and students' English scores, so that the learning content can be more targeted [7]. Based on information technology, Bin Yi, with the main purpose of enhancing the quality and effect of teaching in English for junior and high schools, explored the use of AI technology in teaching in English for junior and high schools, and improved and humanized some functions of the English teaching system [8]. Meng-yue Cao designed and built an intelligent auxiliary system to put artificial intelligence technology into English teaching practice, so as to expand the depth and breadth of modern information technology and open up a new path and goal for college English culture teaching [9]. For the sake of advancing the efficiency of college English cross-cultural teaching, Huiying Xie designed a control experiment based on cloud computing technology and AI according to the actual teaching situation. The performance of the model was confirmed and analyzed from the aspects of effectiveness of laboratory teaching and engaging students in online learning, which can greatly increase the efficiency of English cross-cultural teaching [10]. Among these researchers, the researches on English teaching system are all based on AI, and the research on multimedia English teaching is lacking.

As an intelligent teaching method, multimedia English teaching can improve the teaching classroom, stimulate students' interest in English, and advance teachers' quality with advantages in English teaching that other teaching methods do not have [11]. Multimedia classroom teaching has a variety of contents and flexible teaching models, which represent the new orientation of the development of English teaching in the new era. Only when its connection with traditional teaching methods is bravely explored, and all teachers and students work together to take corresponding preventive measures against various problems in multimedia English teaching, can the promotion of educational reform be truly achieved and the teaching quality be improved.

II. Relevant Theories of Multimedia English Teaching

II. A. Visual Multimedia English Teaching

The so-called multimedia technicality is a process in which information in different fields involved in the computer is comprehensively solved with the help of computers, and a logical order is built between them to a certain extent and to exchange the information with people [12]. For multimedia technology, the only target it involves is the product of the era of the internal structure of electronic computers.

Visual multimedia English teaching is one of the components of modern foreign language teaching technology. It refers to the integration of several news media and the flexible use of relevant mainstream media by teachers according to the needs of different curriculum types [13]. Multimedia aided design teaching conforms to the development of the trend and is gradually forming a new mode of English learning and contemporary education. The multimedia teaching mode centered on electronic information technology has promoted the upgrading of English teaching, which has endowed traditional classroom teaching with a new charm [14]. Multimedia technology has three characteristics. Multimedia teaching has the effect of representation, display, storage and transmission. It is an upgraded approach to teaching and learning with modern technology, which can reduce the macro world, expand the mysterious universe, change abstraction into reality and fiction into reality. It can operate at the same time as the historical time, the future and the present, and can continuously strengthen the students' positive thinking of each sense. It can turn the plane teaching into a dual three-dimensional teaching, so students can positively and efficiently accept information in a relaxed atmosphere. Teachers also have more time to interact with students, improve teaching and upgrade themselves. From the macro perspective, the teaching quality can be improved. The schematic diagram of multimedia English teaching is shown in Figure 1.

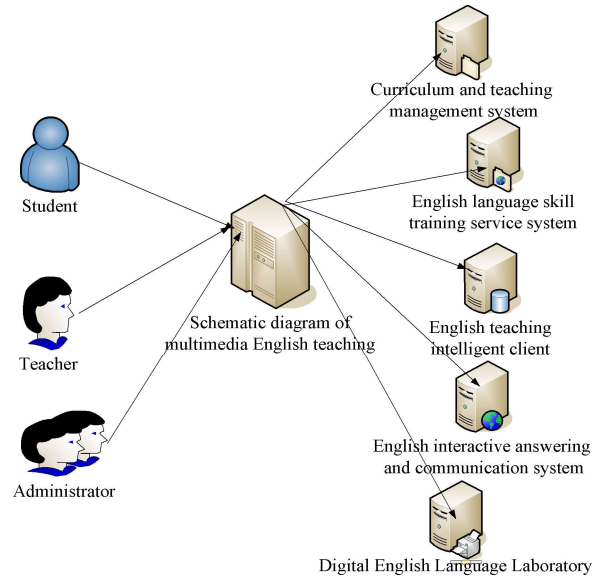


Figure 1: Multimedia English teaching diagram

II. B. Overview of Network Security

The global information wave represented by the Internet is increasingly deepening, and the application of network technology is becoming increasingly popular and profound. At this stage, the main use of network technology has gradually expanded from the past small and medium-sized service systems to large, medium-sized and key business system software, involving a variety of systems [15]. With the popularization of the network, network security has increasingly become a major problem affecting network efficiency. On the premise that the openness, globality and openness of the Internet have improved the degree of freedom of use, it also gives a higher demand for security factors. The flow chart of network teaching service platform is shown in Figure 2.

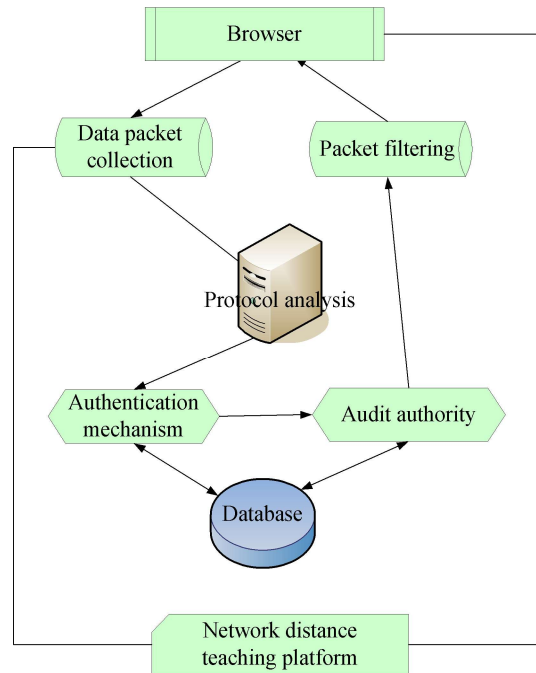


Figure 2: Schematic diagram of network distance learning platform

Because there are many concepts of the Internet, the concept of network security is also different. So far, there is no common perception. It is popularly recognized that network security refers to maintaining the security of information assets so that they are not tampered with or stolen during the transmission process. It can also be

simply said that network security is to maintain the information mobility in the network [16]. In a word, network security refers to the use of a complete set of visual tools and management models to ensure that information can be safely transmitted in the Internet environment and can not be stolen or tampered by illegal authorizers, that is, to guarantee the integrity, safety and usability of data [17]. Network security includes five basic prerequisites. Confidentiality involves ensuring that there is no disclosure of information to unauthorized entities or processes. Integrity means that only licensed customers can modify data and can infer whether data information has been tampered with. Availability means that authorized entities can only browse data information when necessary, that is, network attackers cannot occupy every network resource and block the work of the authorizer. This attack has a denial of service attack. Controllability refers to the ability to control the information inflow and its behavior mode within the authorized scope. Censorship refers to giving investigation basis and methods for network security problems. Part of the hardware configuration of information teaching based on Internet network security is shown in Figure 3.

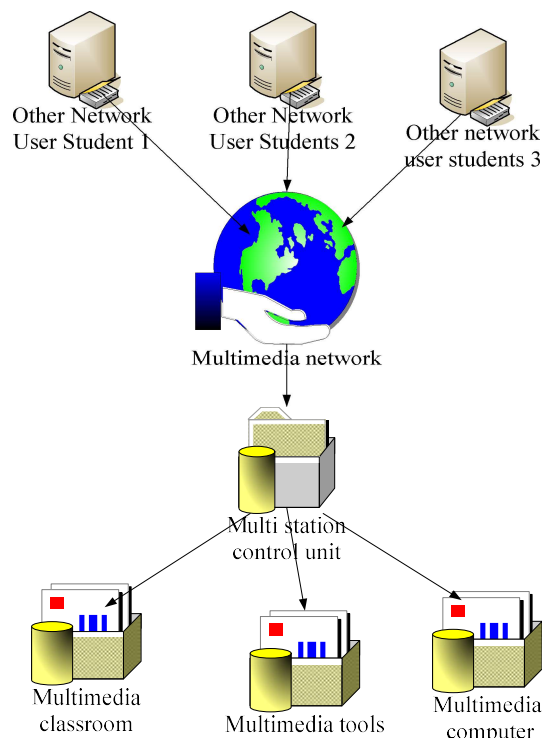


Figure 3: Multimedia teaching hardware based on network security

II. C. Advantages of Multimedia English Teaching

(1) Stimulate students' interest in learning

Multimedia technology has a strong visual effect, which can play animation, songs, videos, etc., and create a feast like visual effect in the form of sound image integration. However, traditional English classroom teaching has many shortcomings, and multimedia English teaching can solve the shortcomings of traditional classroom teaching. Compared with traditional classroom teaching, multimedia English classroom teaching is more specific, fresh and dynamic, which is very easy to attract students' attention and stimulate their interest in learning.

(2) Intuitively present the course content

Multimedia technology has the effect of visual presentation. It can visualize and simplify the complicated English knowledge that is difficult to understand, transform the abstract into concrete, simplify the complex, and present the English knowledge in front of students intuitively and vividly, thus reducing the cognitive difficulty of students on English knowledge. It is different from traditional teaching. Traditional classroom teachers can use blackboard writing design and oral English to discuss and explain English knowledge, instead of presenting English knowledge visually. Therefore, under the premise of multimedia teaching, students are more likely to accept and grasp complicated English knowledge, which is conducive to teachers' breakthrough in teaching difficulties.

(3) Enrich and expand classroom teaching resources

Multimedia technology has the function of combining resources. It can integrate various kinds of classroom teaching resources inside and outside the classroom, including text, short video, pictures, audio and other

resources. It also takes place in classroom teaching in the form of teaching courseware, network connection and other forms. It expands teaching resources and completes the upgrading and utilization of resources. However, most of the traditional classroom teaching resources are concentrated in the scope of books and counseling materials. Not only are there few resources, but also there are not many kinds of resources. There is a lack of dynamic classroom teaching resources. Therefore, multimedia technology has added a lot of dynamic classroom teaching resources and brought many benefits to English classroom teaching.

II. D. Visualization Introduction

“Visualization” is generally translated into “visual, image, visible, pictorial, clear display” in Chinese. It is called actual image because it can be seen according to the structure of human eyeballs [18]. Visualization is generally defined as a way to make complex information easy and quickly understood, which is a way to narrow the language expression of information focused on the key features of information and a way to show graphical interfaces that can magnify people’s feelings. Visualization is the process of transforming data information and knowledge into a visual representation and getting a deep understanding of business [19]. The conversion of daily tasks is likely to be carried out by people or by special tools of electronic computers, which can be used for basic problems or shown by complex systems. It is not difficult to find many from the visual expression. To put it simply, visualization is the whole process of developing visual effects on things and processing them in a graphical way. Therefore, it can be called visualization to turn all abstract things and the whole process into the representation of graphic methods such as image processing. The cognitive theoretical model of visual multimedia learning is shown in Figure 4.

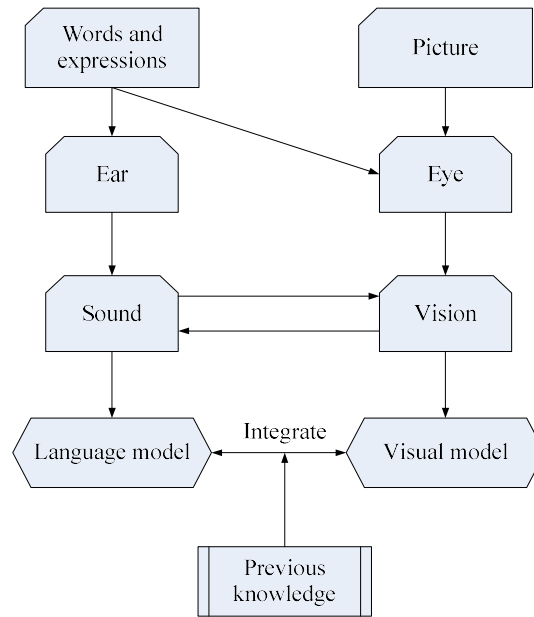


Figure 4: Cognitive theoretical model of visual multimedia learning

Clustering analysis is an important part of the basic theory of system recognition, and unsupervised pattern classification matches with clustering analysis. It has a certain self-organization and coordination ability for data.

The membership relationship of sample $x_i (1 \leq j \leq n)$ to subset $X_i (1 \leq j \leq m)$ can be expressed as follows:

$$\varphi_{x_i}(x_i) = \varphi_{ij} = \begin{cases} 1, & x_j \in X_i \\ 0, & x_j \notin X_i \end{cases} \quad (1)$$

$$W_q = \{\varphi_{ij} | \varphi_{ij} \in \{0,1\}; \sum_{j=1}^n \varphi_{ij} = 1, \forall i; 0 < \sum_{j=1}^k \varphi_{ij} < k\} \quad (2)$$

Among them, the membership function must satisfy the condition of $\varphi_{ij} \in W_q$.

The hard division W_q can only be taken from each item type of the English test paper, that is, reading comprehension, writing, listening and so on. The formula is as follows:

$$W_q = \varphi_i \in W_q | \varphi_{ij} \in \{0,1\}, \forall i \quad (3)$$

The cluster analysis divides the overall target dataset according to the specified similarity measurement rules. Objects in the same cluster should be similar as much as possible, and objects in different clusters should be different as much as possible. The standardized process is as follows. The measurement value of an independent variable is given, and the formula for calculating the average absolute error is as follows:

$$h_g = \frac{1}{q} (|x_{g1} - w_g| + |x_{g2} - w_g| + |x_{g3} - w_g| + \cdots + |x_{gq} - w_g|) \quad (4)$$

Among them, $x_{g1}, x_{g2}, x_{g3}, \cdots, x_{gq}$ are the average values of q measures of variable g , namely, $w_g = \frac{1}{q} (x_{g1} + x_{g2} + x_{g3} + \cdots + x_{gq})$.

The standardized measure is calculated as follows.

$$y_{gi} = \frac{x_{gi} - w_g}{h_g}, i = 1, 2, \cdots, q \quad (5)$$

In addition to the above operators, a new operator is defined in the clustering algorithm, which includes the following two steps.

$$\varphi_{ij} = \frac{(\sum_{l=1}^n (B(x_j, q_l))^{-2})^{-1}}{(B(x_j, q_l))^2}, \forall i, j \quad (6)$$

$$q_i = \frac{\sum_{j=1}^k \varphi_{ij}^2 x_i}{\sum_{j=1}^k \varphi_{ij}^2} \quad (7)$$

II. E. Application of AI Technology in English Teaching

As a cross cutting frontier discipline, AI has influenced the public's thinking mode and traditional concepts and improved people's knowledge and education [20]. In the course of education development, the professional technology of breaking the old and creating the new usually gives strong impetus to the transformation of education, making education and teaching more efficient and convenient, and making education more fair, universal and popular. With the progress of AI technology and the expansion of English teaching databases, AI can help English teachers and students to some extent in the classroom, because its effectiveness can replace some special roles of teachers in English teaching. At the same time, AI can also assist teachers in curriculum management, such as preparing lesson plans, preparing textbooks, designing classroom teaching activities, etc. With the support of special AI tools, English learners can also self-study pronunciation, vocabulary, reading articles, English listening, writing and oral English at any time. Therefore, it can be seen that some features of AI in English learning at this stage include the utilization of big data support to provide personalized studying, simulated teacher guidance and immersive experience. The specific learning features are shown in Figure 5.

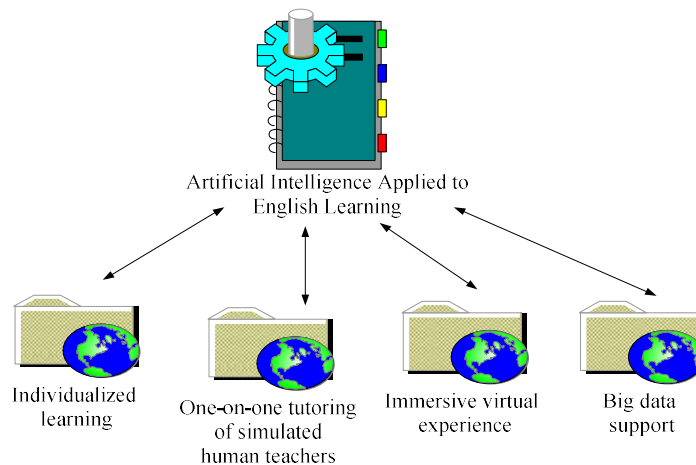


Figure 5: Features of AI technology applied to English learning

III. English Teaching Experiment

In order to further verify what changes the visual multimedia English teaching in terms of network security has on the progress of English for the students in the context of artificial intelligence, the effect of visual multimedia English teaching was compared with traditional English teaching. Two classes were randomly selected, Class 1 and Class

2. Class 1 is an experimental class, which uses visual multimedia English teaching methods for English teaching. Class 2 is a control class, taking traditional English teaching approach. English were taught by same teacher. The detailed information of the students in the two classes is shown in Table 1.

Table 1: Specific information of students in Class 1 and Class 2

Class	Class 1	Class 2
Boy classmate	20	22
Girl classmate	25	23
Total	45	45

English is a language, so it is very important to cultivate students' ability to pronounce accurately and skillfully. In this regard, in the English class, teachers used various methods to teach, which is to strengthen and cultivate students' English listening and speaking ability. In order to test the improvement of students' English listening and speaking ability by visual multimedia English teaching method based on network security, oral test and English listening test were conducted for two students in Class 1 and Class 2. Oral test is divided into English conversation test and English article reading test. The scores of oral test and listening test are both 25 points. The final results of the students in the two classes take the average. The specific scores are shown in Figure 6.

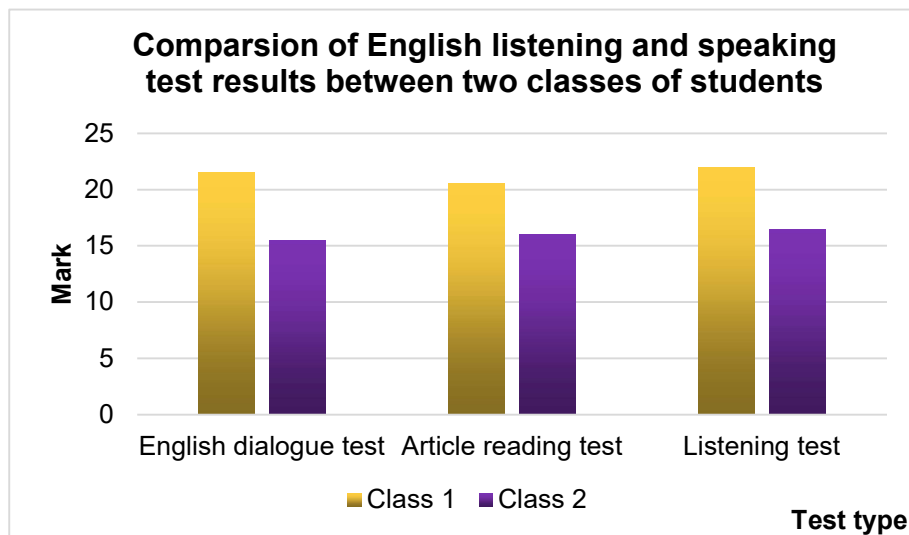


Figure 6: Comparison of English listening and speaking test results between two classes

Through the observation of Figure 6, it can be found that the visual multimedia English teaching method based on network security is very helpful to the improvement of students' listening and speaking scores. Compared with traditional English teaching methods, the listening and speaking scores were significantly improved. Class 1 using visual multimedia English teaching had a score of more than 20 points, while Class 2 using traditional teaching methods had an average score of less than 17 points. Among them, Class 1 had the highest average score in the listening test, with 22 points, while Class 2 had only 16.5 points, 5.5 points higher than Class 2. Class 1 had the lowest average score in the article reading test, which was only 20.5 points, but 4.5 points higher than Class 2. Class 2 had the lowest average score in English conversation test, with only 15.5 points, 6 points lower than Class 1. The visual multimedia English teaching based on network security can better improve students' listening and speaking ability. Because when using the visual multimedia system to carry out English listening training, the video listening material content can be played according to the multimedia system, and each English listening material content corresponds to a small video, so that students' English listening ability can be improved. At the same time, the scene interface in the life is displayed according to the multimedia broadcast, so that the students can integrate the divergent thinking of the scene, imagine themselves as the people in the scene, and organize the English language to train the students' English expression ability.

The research object of this paper can not only improve students' listening and speaking ability, but also improve their overall ability. After the two classes used different aspects for a semester of English teaching, they took a set of test paper for the students of the two classes to test. The test paper was mainly divided into five types, namely

listening, reading comprehension, single choice, cloze filling and writing. The total score of these five categories is 100 points. Students in Class 1 and Class 2 used this set of test paper for testing. The average value was taken from the test score. The scores of various types of questions are shown in Figure 7.

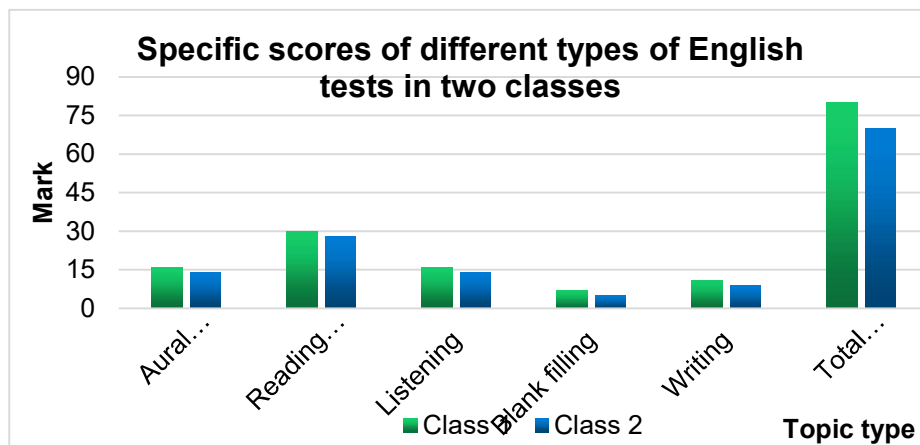


Figure 7: The specific scores of the two classes in different types of English tests

As shown in Figure 7, based on network security, the scores of English test scores of Class 1 using visual multimedia teaching methods for English teaching were much higher than those of Class 2 using traditional teaching methods. Concurrently, the total mean points of Class 1 was also higher than that of Class 2. The total average score of Class 1 was 80 points, while that of Class 2 was 70 points. Class 1 was 10 points higher than that of Class 2. Among them, the total score of reading comprehension was 35; the average score of Class 1 was 30, and that of Class 2 was 28; Class 1 was 2 points higher than Class 2. The total score of writing was 15, and that of Class 1 was 11, which was 2 points higher than that of Class 2. The total score of listening was 20, and the average score of Class 1 was 16, which was 2 points higher than Class 2. The application of visual multimedia in English teaching can deliver vivid and interesting teaching information for students, reasonably stimulate students' every sense to participate in learning and training activities and students' enthusiasm, and improve their English scores.

The utilization of AI in English teaching and learning can make the most of its powerful role and can more effectively meet the requirements of English learners. Two classes were randomly selected for a control experiment. Class A uses a multimedia teaching method in English according to AI technology, that is, the experimental class. Class B is a control class using traditional teaching methods. Same teacher gave English lectures to the two classes. The time of the control experiment is one semester, and the experimental results are mainly reflected through the initial scores, mid-term and final scores. The final results of the scores are the average of the total scores. The specific scores of the initial, mid-term and final results of the two classes are shown in Figure 8.

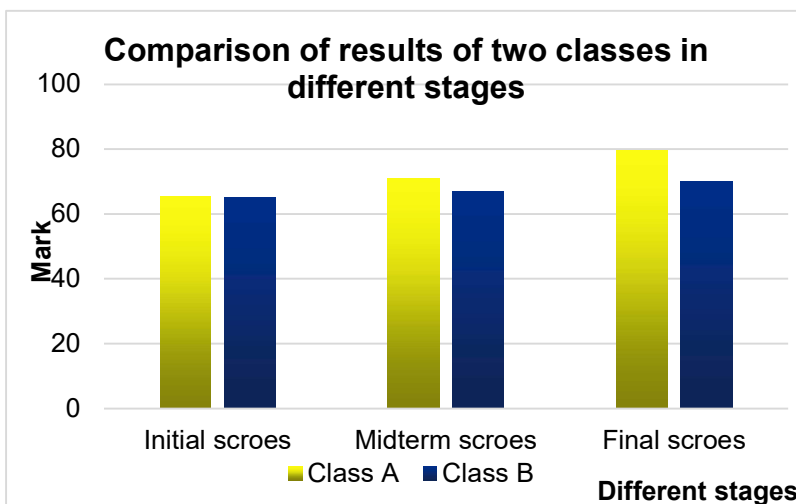


Figure 8: Results of comparison between the two classes at different stages

As shown in Figure 8, the English performance of Class A with the multimedia English teaching method based on AI technology was greatly improved than that of Class B with conventional teaching methods. The initial scores of the two classes were almost the same. The scores of Class A and Class B were 65.5 and 65, respectively. The difference between the two classes was only 0.5. However, with the help of multimedia English teaching methods based on AI, Class A's English scores were significantly improved. The middle grade of Class A was 71 points, which was 5.5 points higher than the initial score; while the middle grade of Class B was only 67 points, which was 2 points higher than the initial score and 4 points lower than the middle grade of Class A. Toward the close of the semester, the changes between the two classes were more obvious. The final score of Class A was 79.5, which was 8.5 points higher than the mid-term score and 14 points higher than the initial score. After one semester, based on AI technology, the English score of Class A was improved qualitatively. The final score of Class B was only 70 points, which was 3 points higher than the mid-term score. At the same time, the final score of Class B was 9.5 points lower than that of Class A. After a semester, under the traditional teaching methods, the English scores of Class B did not changed significantly. By comparing the results of the three English exams of Class A and Class B, it can be proved that the multimedia teaching method based on AI can improve students' English scores.

IV. Conclusions

English is not only a widely used international language, but also a special tool to learn the cutting-edge technology of western countries and promote China to communicate with other countries more. Nowadays, there is a growing interest in learning English. Correspondingly, they put forward higher requirements for English teaching. With the fast growth of intelligent network technology, visual multimedia has long been popularly used in English teaching, bringing many benefits to English teaching. Therefore, in the light of AI, based on network security, this paper used visual multimedia English teaching methods to carry out teaching. Teachers can closely combine multimedia and vocabulary teaching, reading article teaching and writing teaching, fully use the effectiveness of multimedia assisted teaching, and improve the quality of English teaching in an all-round way. At the same time, this paper also used AI technology to carry out multimedia teaching, and it was found that multimedia teaching method based on AI technology can improve students' English scores more effectively than the traditional teaching method.

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Reference

- [1] Haryudin, Acep, and Farhan Imanullah. "the Utilization of Kinemaster Applications in the Making of Multimedia Based Teaching Materials for English E-Learning in New Normal (Covid-19)." *PROJECT (Professional Journal of English Education)* 4.2 (2021): 341-352.
- [2] Aljazzaf, Zainab. "Factors influencing the use of multimedia technologies in teaching English language in Kuwait." *International Journal of Emerging Technologies in Learning (IJET)* 15.5 (2020): 212-234.
- [3] Dos Santos, Luis M. "English language learning for engineering students: Application of a visual-only video teaching strategy." *Global Journal of Engineering Education* 21.1 (2019): 37-44.
- [4] Kamelia, Kamelia. "Using video as media of teaching in English language classroom: expressing congratulation and hopes." *Utamax: Journal of Ultimate Research and Trends in Education* 1.1 (2019): 34-38.
- [5] De Jager, Lizette, Christopher Rwodzi, and Nhlanhla Mpofu. "The innovative use of social media for teaching English as a second language." *TD: The Journal for Transdisciplinary Research in Southern Africa* 16.1 (2020): 1-7.
- [6] Shu, Yang. "Experimental data analysis of college English teaching based on computer multimedia technology." *Computer-Aided Design and Applications* 17.S2 (2020): 46-56.
- [7] Sun, Zhuomin, M. Anbarasan, and D. J. C. I. Praveen Kumar. "Design of online intelligent English teaching platform based on artificial intelligence techniques." *Computational Intelligence* 37.3 (2021): 1166-1180.
- [8] Bin, Yi, and Durbadal Mandal. "English teaching practice based on artificial intelligence technology." *Journal of Intelligent & Fuzzy Systems* 37.3 (2019): 3381-3391.
- [9] Meng-yue, Cao, Li Dan, and Wang Jun. "A Study of College English Culture Intelligence-Aided Teaching System and Teaching Pattern." *English Language Teaching* 13.3 (2020): 77-83.
- [10] Huiying, Xie, and Mai Qiang. "College English cross-cultural teaching based on cloud computing MOOC platform and artificial intelligence." *Journal of Intelligent & Fuzzy Systems* 40.4 (2021): 7335-7345.
- [11] He, Wanlin. "The effects of applying multimedia in primary English language teaching in China." *PJEIS: Parahikma Journal of Education and Integrated Sciences* 1.1 (2021): 9-15.
- [12] Kumar, Tribhuwan. "Analyzing multimedia tools and language teaching." *Linguistics and Culture Review* 5.S1 (2021): 331-341.
- [13] Amin, Md, Mahedi Azim, and Md Kalam. "The benefit of using multimedia projector in English Language teaching classroom." *International Journal of Social Sciences & Humanities* 3.1 (2018): 62-76.
- [14] Wu, Miqin. "The Application of Multimedia in English Teaching." *Frontiers in Sustainable Development* 1.7 (2021): 91-97.
- [15] Suzuki, Naoki. "100 Gb/s to 1 Tb/s based coherent passive optical network technology." *Journal of Lightwave Technology* 36.8 (2018): 1485-1491.



- [16] Guo, Hongzhi. "A survey on space-air-ground-sea integrated network security in 6G." *IEEE Communications Surveys & Tutorials* 24.1 (2021): 53-87.
- [17] Wu, Hsin-Te, and Chun-Wei Tsai. "An intelligent agriculture network security system based on private blockchains." *Journal of Communications and Networks* 21.5 (2019): 503-508.
- [18] Holt, Christine E., Kelsey C. Martin, and Erin M. Schuman. "Local translation in neurons: visualization and function." *Nature structural & molecular biology* 26.7 (2019): 557-566.
- [19] Pettersen, Eric F.. "UCSF ChimeraX: Structure visualization for researchers, educators, and developers." *Protein Science* 30.1 (2021): 70-82.
- [20] Haenlein, Michael, and Andreas Kaplan. "A brief history of artificial intelligence: On the past, present, and future of artificial intelligence." *California management review* 61.4 (2019): 5-14.