Computer Assisted Instruction Hybrid Teaching System Construction for Art Design Majors

Peijie Chen[1*] and Yuanting Zheng[2]

[1]Department of Arts and Physical Education, Jieyang Polytechnic, Jieyang 522000, China, cpj@jyc.edu.cn
[2]Department of Economics and Management, Jieyang Polytechnic, Jieyang 522000, China, zhengyuanting521@163.com

*Corresponding author: Peijie Chen, cpj@jyc.edu.cn

Abstract. To improve the efficiency and effectiveness of lectures of art design majors, this paper designs a hybrid teaching system for computer-aided design courses, which includes online lecture subsystem, front and back-end network communication subsystem, multi-client interaction subsystem and user management system, where the online lecture system includes live lecture function and art design related assignment submission and correction function, the front and back-end network communication system includes The front-end and back-end network communication system includes the network communication architecture design of the system, and the multi-client interaction system includes the design ideas and interaction mode design for the clients of personal computers, Android and IOS system cell phones and platform computers. The user management system includes the authority division and permission management functions for different status users such as students and teachers. To assessment the effectiveness of the designed system, we designed two sets of comparison experiments to compare with the traditional lecture method in terms of teacher's lecture time and student's learning efficiency, the comparison results denote that the proposed lecture assistance system can significantly reduce the teacher's lecture time and effectively improve the student's learning effect at the same time.

Keywords: Art design; computer assisted instruction; teaching system; computer-aided interaction
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1 INTRODUCTION

With the in-depth of the reform of higher education, in addition to the reform of course contents, it is more important to reform the teaching methods. Among them, with the advancement of computer and multimedia technologies in recent years, computer assisted instruction (CAI) teaching system has become an important part of modern teaching system. Especially, with the

spread of the global COVID-19 epidemic in the past two years, the need for computer-assisted teaching systems [1] that support online teaching has become more urgent. Unlike other courses, the courses of art and design majors have a lot of lecture needs in graphics and images, so the traditional online lecture system of text and voice teaching cannot fully meet the teaching needs of art and design majors. In the process of teaching art and design majors [2], students need to participate in a lot of graphic drawing work, and often need to submit drawing assignments. In the process of lecture, teachers also need to display a lot of graphic images, and the online teaching requires low system latency and high synchronization of sound and picture. Considering that when teaching online, students may use multiple types of clients, including personal computers, cell phones, tablets and other devices, the system should support multiple types of clients to improve its compatibility.

To meet the teaching needs of art design majors, a hybrid teaching system for computer-aided design courses in art design majors is designed, which includes online lecture subsystem, front and back-end network communication subsystem, multi-client interaction subsystem and user management system, where the online lecture system includes live lecture function and art design related assignment submission and correction function, the front-end and back-end network communication system includes the network communication architecture design of the system, and the multi-client interaction system includes the design ideas and interaction mode design for the clients of personal computers, Android and IOS system cell phones and platform computers. The user management system includes the authority division and permission management functions for students, teachers and other users with different identities. We have briefly evaluated the functions and efficiency of the designed teaching system, and the evaluation results denote that the designed teaching system can effectively meet the teaching needs of art and design majors.

2 RELATED WORK

CAI is a method and technology to conduct various teaching activities with computer assistance, discuss teaching contents, teaching arrangement and teaching training with students in a dialogical way. CAI provides a good personalized learning environment for students. The integrated application of computer technologies such as hypertext, multimedia, network communication, artificial intelligence have overcome the shortcomings of the traditional teaching scenario in a single, one-sided way. Multimedia computers have brought a revolution to computer-assisted teaching. Multimedia is not only a simply combined media, but a variety of media organically combined into a unified system, whose overall function is stronger than the sum of various media functions. The requirements of education for media are getting higher and higher. It can be said that multimedia is the main development direction of computer-assisted teaching in the future. The emergence of multimedia computers is a revolution of computers, which has the ability to synthesize text, images, sound and graphics, showing the significant advantages of computers in education and soon becoming an important direction of CAI development.

In recent years, many researchers have investigated CAI and proposed several important approaches. Tian and Duan [3] proposed a computer-aided system to assist in scheduling lessons, and designed an efficient scheduling algorithm based on genetic algorithm, which can effectively improve the scheduling efficiency and can meet the scheduling needs of a variety of courses and can make fuller use of the curriculum and teacher resources. Adigun [4] investigated the role of computer-assisted systems for deaf people who have lost their hearing in learning biology, and verified through controlled experiments that CAI can significantly enhance the learning ability of deaf people for biology, and the results denote that CAI can play an important supporting role in teaching tasks. Kaleli [5] proposed a CAI teaching system for piano courses and designed a controlled experiment to compare the use of CAI with conventional teaching methods. Kara [6] calculated the acceptance of CAI by art teachers, and the results showed that art classrooms are more receptive to advanced skills and CAI, therefore, it can be assumed that CAI applied to art curriculum support system will be easily accepted by teachers. Ugwuanyi and Okeke [7] studied

the effect of CAI on the performance of students in physics and compared learning outcomes through a controlled experiment, the results denote that CAI can significantly improve students' performance in physics, further demonstrating the beneficial effects of CAI in teaching and learning tasks. Usman and Madudili [8] analyzed the effect of CAI on Nigerian. The results denote that CAI has a significant positive effect on teaching and learning. Kaye and Ehren [9] analyzed the positive effect of CAI in education in low-income and middle-income economies by developing a model to assess the role of CAI in learning and teaching through the use of secondary data analysis. The results denote that CAI has a significant positive effect on teaching and learning. Hsu et.al. [10] designed a CAI system that can be used to assist in makeup design, which can effectively enhance students' independent design ability and interaction with the teacher through computer graphics design.

Existing CAI systems are mainly for scenario-specific applications. Considering online education and interoperability in art classroom teaching, a complete and effective teaching aid system needs to be designed in a targeted manner.

3 DESIGN OF COMPUTER-ASSISTED INSTRUCTION HYBRID TEACHING SYSTEM FOR ART DESIGN MAJORS

Considering the needs of art and design majors, an online lecture system with live streaming function will effectively assist the classes. In this paper, we designed an assisted teaching system, including live teaching subsystem, front and back-end network communication subsystem, multi-client interaction subsystem and user management subsystem, and the architecture is shown in Figure 1.

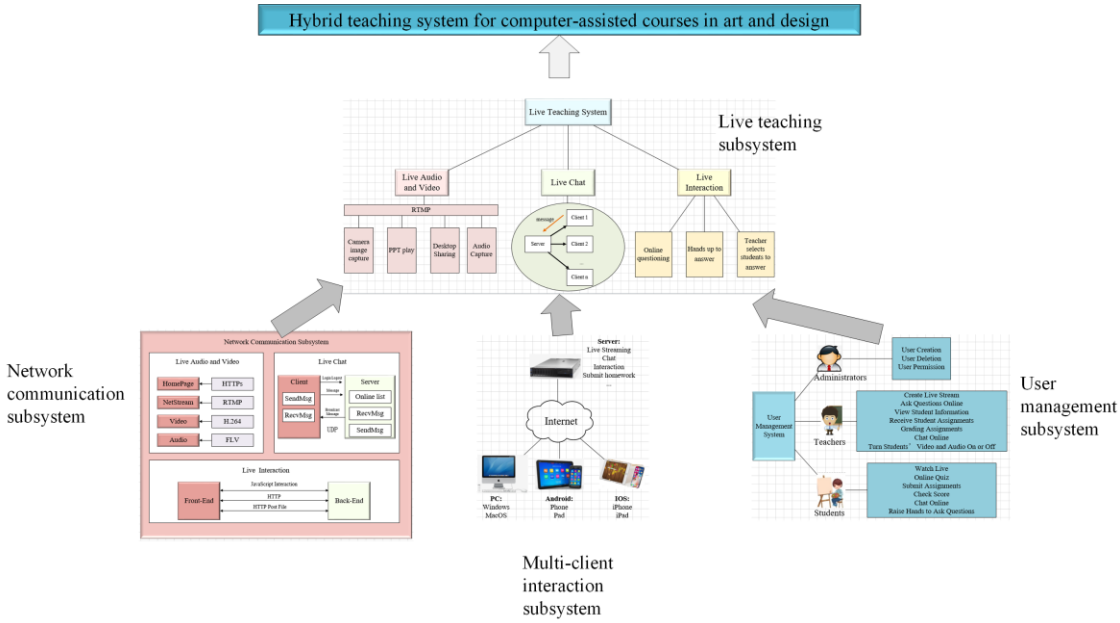

Figure 1: The architecture of the computer-assisted instruction hybrid teaching system.

3.1 Live Teaching Subsystem

To meet the needs of online teaching in the new era, the lecture system designed in this paper supports live teaching function. With the fast advancement of mobile Internet in the past several years, live webcasting is gradually familiar and accepted by the public. Through the easy operation of computers and smartphones, people can not only watch the live video content being broadcast at anytime and anywhere, but also communicate and interact with the organizer and other viewers

on the stage at any time to further enhance the enthusiasm of watching. With the characteristics of real-time, interactivity, ease of use, and wide coverage, Internet live streaming has been applied in industries such as news, e-sports, e-commerce retail, and film and entertainment. Based on the background above, this paper makes use of the existing network environment and live streaming technology to establish a set of webcasting system serving interactive teaching and learning, so that limited high-quality educational resources can be used in the form of live video streaming to enable teachers and students to answer questions, chat and other interactive teaching scenarios in the system.

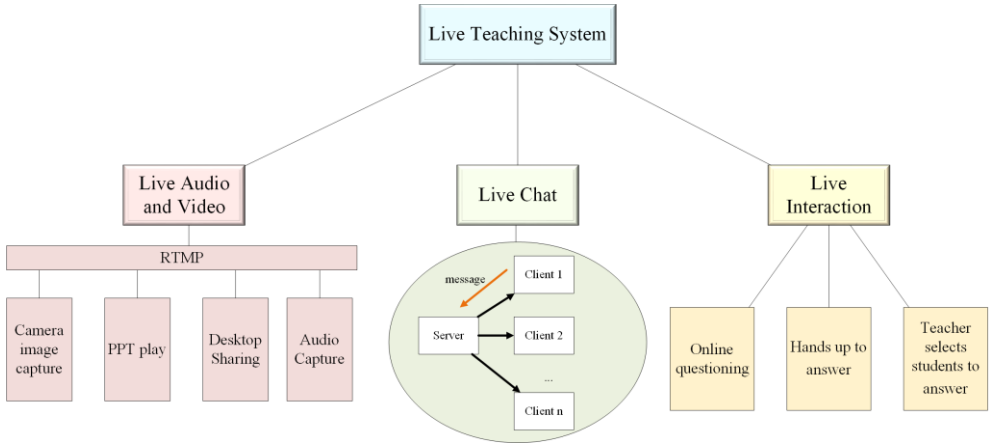

Figure 2: The architecture of live teaching system.

The complete live teaching system includes live video function, chat function, and live interactive function, as shown in Figure 2. Among the system, live video needs to support camera image capture, PPT playback, desktop sharing, sound capture, etc. The video can be designed using RTMP protocol, while the audio can be encoded into FLV format and pushed using RTMP protocol, which can realize the live broadcast function with about 100ms delay time. PPT playback function mainly supports desktop system PPT image capture, need to support common PPT playback software, and encoded as a video stream using the RTMP protocol push. The desktop sharing function is similar to the PPT playback function, which can capture desktop images and encode them as video streams for pushing. The chat function is designed based on the message broadcasting mechanism, which records all online clients on the server side and broadcasts to all clients after any client sends a message. In online teaching system, the design of live interactive function is especially important because teachers and students cannot communicate face to face. Considering the teaching needs, we designed the live interactive function which includes online question asking function, hand-raising function, and teacher spot-checking function. The online question function supports the teacher to edit the questions online, and the students will answer them, and the results will be counted, while the teacher can check the answers of specific students. The hand-raising function is mainly used for students to raise their hands to answer the questions, and the teacher selects students to answer. The teacher spot-check function supports the teacher to name students to answer the questions, and can automatically open the student video and microphone. The live interactive function also needs to provide online assignment submission function. Considering the demand of art design lectures, the files provided by students may be pictures, documents and source files of design software, so it needs to support multiple formats of file upload function, the teacher can view and download the assignments submitted by each student, and give grades online, and students can view their own grades.

Based on the live teaching system, teachers can fully communicate with students during online lectures, while the online live interaction function will be richer than offline interaction, students can realize video recording and review during the learning process, and can improve learning outcomes through repeated learning after class. Therefore, live teaching system can play an important role in CAI teaching.

3.2 Network Communication Subsystem

To achieve an effective teaching aid system, the communication methods between different software modules in the system need to be optimally designed. The software modules that require network communication include live function pages, video and audio data stream push, communication function of live chat system, communication design of interactive function and communication design of assignment submission. The design of the communication system is shown in Figure 3.

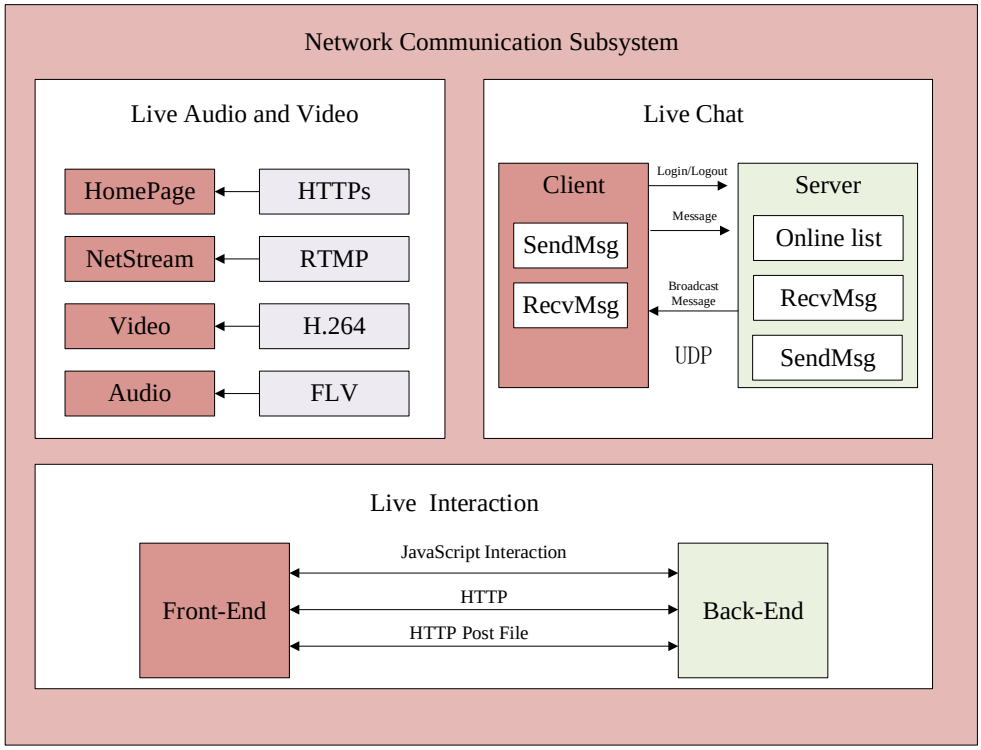

Figure 3: Design of network communication subsystem.

The live broadcast page in the system is mainly designed based on HTML5 technology. For the access of the page, HTTP protocol can be used for the design, and HTTPs protocol based on TLS encryption can be used for the communication considering the communication security. For the video and audio in the live broadcast, the RTMP protocol is used for communication, and the FLV files of video images and audio are encoded into H.264 format data for network transmission, and the RTMP protocol supports on-demand in the form of HTTP, which can be easily embedded in the front-end page. For the chat system, considering the real-time requirements of communication, UDP protocol is used for communication, and the communication architecture is client-server structure. When the client is online, it sends a login request to the server, and the server records

the IP and port of the current client and marks it as login status. Realize that all live viewers can see the real-time message. Considering the security of the communication content, the communication protocol uses a private communication protocol, and the communication content is encrypted using an encryption algorithm to avoid the communication content being intercepted by a third party. The interactive function is mainly designed based on JavaScript, and the communication protocol is mainly http protocol. When interaction occurs between the front-end and the back-end, it is mainly calculated and analyzed by the back-end, and finally fed back to the front-end page to realize the interactive function. In the assignment submission function, considering that most of the art design submissions as photos or files in various formats, HTTP is used to upload the files and save them in the server for classification and provide a page for the teacher to download and view.

By using various types of network communication protocols, a complete communication system can be constructed for the supplementary teaching system to achieve complete interactive functions.

3.3 Multi-client Interaction Subsystem

The CAI teaching system contains various types of clients and servers, and the system architecture is shown in Figure 4.

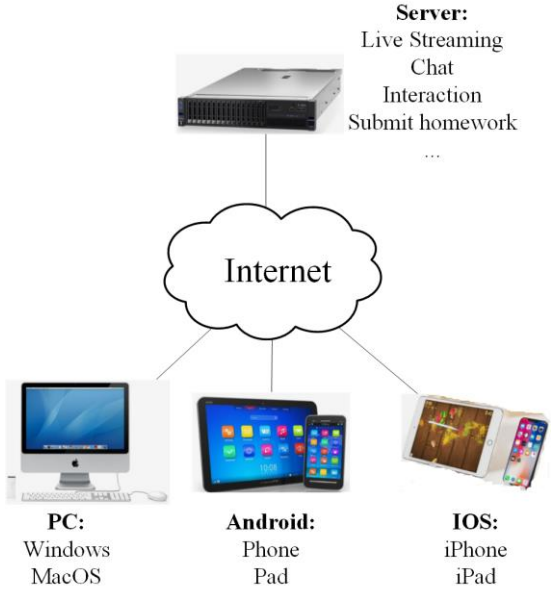

Figure 4: Design of network multi-client interaction subsystem.

The CAI teaching system contains many types of terminals. Teachers mainly use personal computers to teach, and need to play PPT or share screen, so they need to have a client that supports windows, and for more comprehensive support, they also need to support Apple MacOS client software. The client software for personal computer is developed based on C++, which mainly includes front-end page acquisition and some basic human-computer interaction functions. For students, the clients for watching lectures may include Android phones, Apple phones or tablets, therefore, client software supporting Android and IOS is needed. The Android client is mainly developed based on JAVA language, while the IOS client is developed using Object-C. The client software on cell phones and tablets has basically the same functions and development methods, and only needs to be fine-tuned for different resolutions. The mobile client software is mainly equipped with live video access and interactive functions. The implementation of the main

functions is concentrated on the backend server, including live streaming, chat, interactive functions and job submission, etc., all by the server to complete the relevant functions, communication interface is mainly developed by JAVA, and some functions are developed using C++.

By providing client software on different types of terminals, combined with unified server software, a multi-client interactive system that can be easily extended can be realized, thus better supporting the design of supplementary teaching systems.

3.4 User Management System

The assisted teaching system needs to manage the identity of teachers and students, and divide the user rights of different identities. The architecture of user management system in this paper is shown in Figure 5. The user identities in the system include administrator, teacher and student. Among them, the administrator has the highest authority and can manage other users' identity and authority in the background, add or delete user accounts, and set different authority for different users. The teacher's privileges are mainly focused on teaching-related matters, including opening and closing the live broadcast, adding assignments, sending messages to students, turning on or off the student camera and microphone, creating questions online, checking students' grades, viewing the results of class statistics, downloading and reviewing students' submitted assignments in the background, and giving comments and scores online. The student account has a single permission, mainly for watching the teacher's live lectures, answering the teacher's questions online, submitting assignments, and checking their scores. The administrator account cannot be registered, it is set by the server developer, and can be managed by a designated person, and the user account can be modified. Teacher and student accounts support independent registration, which can be completed after review by the administrator, and the corresponding rights can be automatically assigned after registration. Teacher and student accounts can be logged out independently and can be deleted by the administrator.

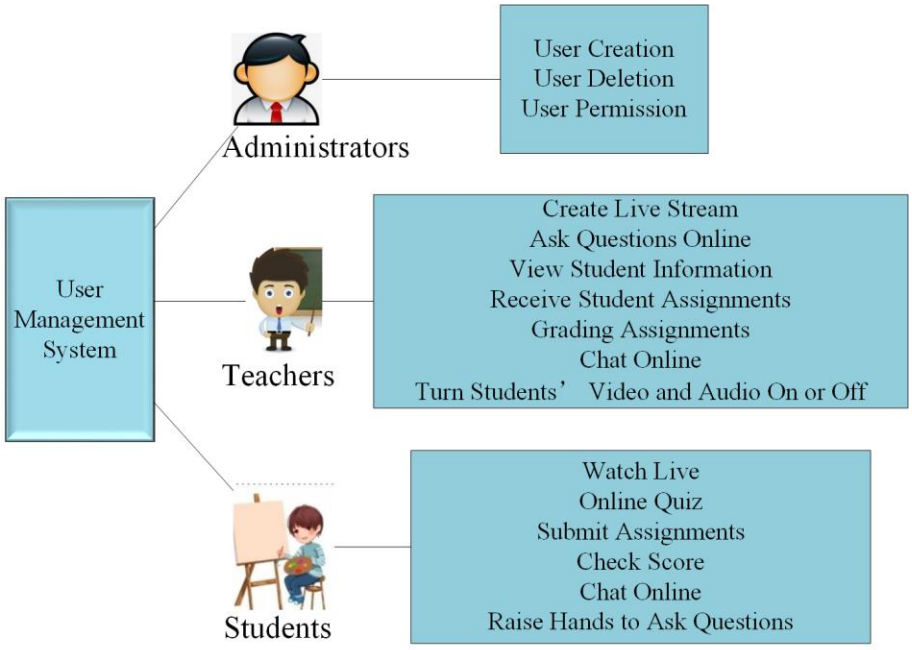

Figure 5: Design of network multi-client interaction subsystem.

Perfect user management and authority management can effectively support the design of the teaching aid system, which is crucial to the user experience. This paper considers the design of user identity and authority from various aspects, which can effectively improve the ease of use of the system.

4 ANALYSIS OF RESULTS

4.1 Teaching Time Assessment

To fully evaluate the effect of the proposed assisted lecture system on the efficiency of teachers' lectures, we designed a comparison experiment to compare the completion time of traditional lectures with the proposed lecture system under the use of the same lecture content, class questions, assignments, and homework corrections, and the results are shown in Figure 6.

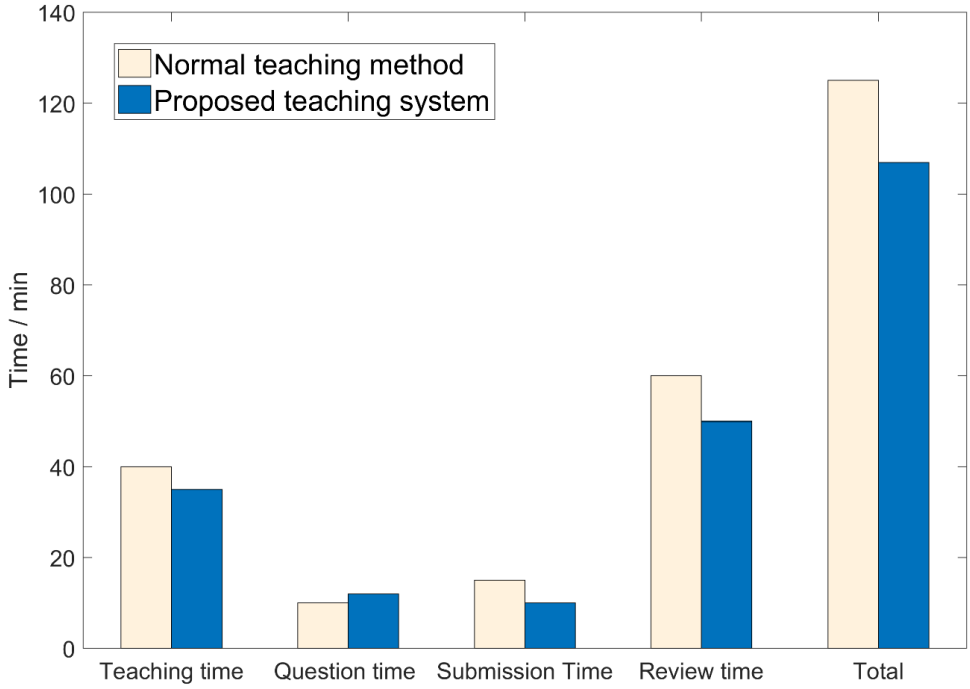

Figure 6: Comparison results of teaching time.

In terms of lecture time, the online system reduced the lecture time slightly from 40 minutes to 35 minutes because the instructor could sit down and use the personal computer to operate the PPT. In the questioning session, since online communication is not as smooth as offline communication, the time for the questioning session increased from 10 minutes to 12 minutes, but the online session allows all students to answer the questions anonymously online, so the teacher can see the correct rate of the whole class and effectively control the overall learning level of students on the questions, so it is worth the small loss of time. In the student assignment submission process, the unified online submission portal makes it easier to submit assignments and allows for photo submissions, reducing the average assignment submission time from 15 minutes to 10 minutes. For the homework correction, the teacher can easily browse each student's homework online, and can score it with one click and get the score statistics quickly, reducing the homework correction time from 60 minutes to 50 minutes. Therefore, the overall time of this lecture is reduced from

125 minutes to 107 minutes, which shows that the proposed computer-assisted teaching system can effectively improve the efficiency of the teacher's lecture.

4.2 Student Learning Effectiveness Assessment

To evaluate the improvement of students' learning efficiency by the proposed teaching aid system, a control experiment was designed in which two classes with close usual scores were selected, one class using traditional lectures and one class using the teaching aid system of this paper, and the average grades of assignments after ten lectures were compared, and the comparison is shown in Figure 7.

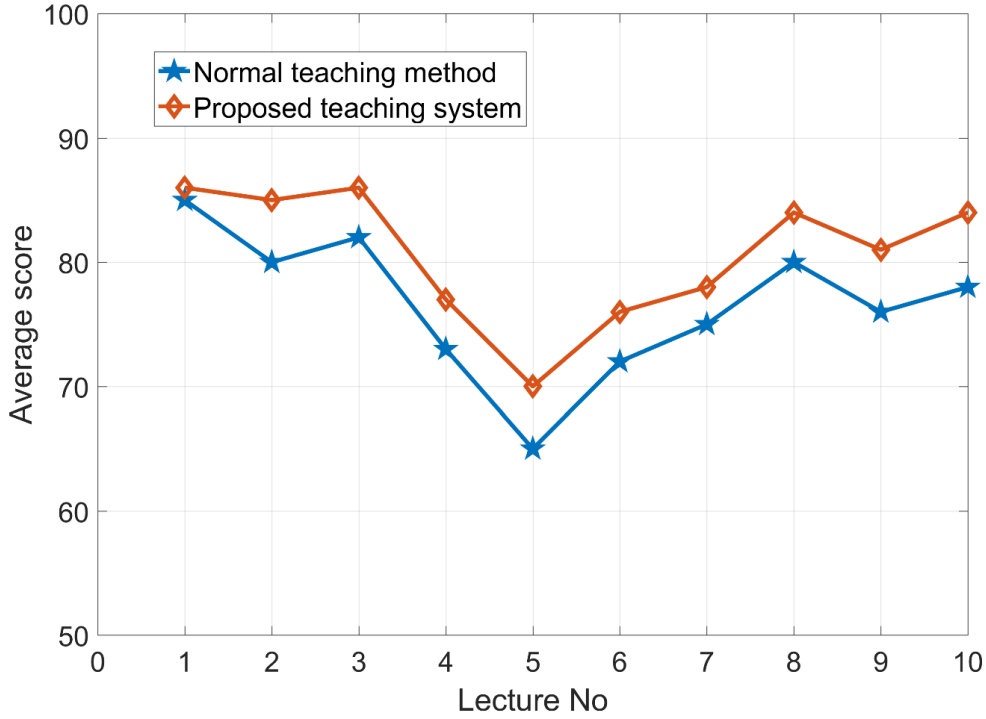

Figure 7: Comparison of the average score of learning by proposed system and traditional method.

It can be seen from Figure 7, the average scores of the classes using the proposed lecture assistance system significantly higher than those of the classes with the traditional lecture method in all 10 lecture tasks, in which, only in the first time, the scores of the two classes were closer because the course was easier and the first time the assistance lecture system was used. In the subsequent courses, however, the average scores of the classes using the system in this paper were all significantly higher than those of the comparison classes. After consulting and analyzing the students, it was found that when using the online lecture system, students could video record the course content and repeat it after class, so they had a more comprehensive knowledge and were more relaxed in completing assignments after class. The results of the comparison experiments show that the proposed lecture support system can effectively enhance students' learning.

Two comparative experiments are designed to assessment the effectiveness of the proposed lecture support system in terms of teacher's lecture time and students' learning effectiveness. The comparison results denote that the proposed lecture assistance system can significantly reduce the teacher's lecture time and effectively improve the students' learning effect at the same time.

5 CONCLUSION

This paper designs a hybrid teaching system of computer-aided design course for art design majors, which includes online lecture subsystem, front-end and back-end network communication subsystem, multi-client interaction subsystem and user management system, where the online lecture system includes live lecture function and art design related assignment submission and correction function, the front-end and back-end network communication system includes the network communication architecture design of the system, the multi-client interaction system includes the design ideas and interaction methods for clients of personal computers, Android and IOS systems and platform computers. The front-end and back-end network communication system includes the network communication architecture design of the system, and the multi-client interaction system includes the design ideas and interaction mode design for the clients of personal computers, Android and IOS system cell phones and platform computers. The user management system includes the authority division and permission management functions for different status users such as students and teachers. To assessment the effectiveness of the designed system, we designed two sets of comparison experiments to compare with the traditional lecture method in terms of teacher's lecture time and student's learning efficiency, and the comparison results denote that the proposed lecture assistance system can significantly reduce the teacher's lecture time and effectively improve the student's learning effect at the same time.

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Peijie Chen, https://orcid.org/0000-0002-1683-7919
Yuanting Zheng, https://orcid.org/0000-0002-1893-3947

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