



# Multimodal Fusion Blended Teaching Under the New Era of “Internet+” Education

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**Abstract.** With the rapid development of information and intelligent technology, education informatization is constantly promoted and upgraded, which can open up opportunities for implementing innovative teaching methods for “Internet+” education. Institutions of higher education in China adopt various ways to actively carry out online teaching, and promote the research of online teaching practice. The teaching methods for the courses in intelligent building engineering technology specialty in Dongguan Polytechnic are presented as examples in this paper. Multimodal fusion in blended teaching is practiced and explored in these professional courses, which included Small Private Online Course (SPOC) combing with flipped classroom scheme, integration of course and 1+X certificate of vocational skill level, project site online demonstration and so on. The implementation of online flipped classroom is effectively promoted by the proposed multimodal fusion blended teaching, and more efficient teaching effect is achieved.

**Keywords:** Education informatization · Blended teaching · Flipped classroom · Vocational skill

## 1 Introduction

With the rapid development of information technologies such as Artificial Intelligence (AI), 5G technology, big data, and Virtual Reality (VR), the integration of teaching methods into the intelligent environment has become a key measure for the revolutionary impact of “Internet+” education. These information technologies can promote the transformation and upgrading of education informatization, fully stimulate the integration of information technology into education, and accelerate the implementation of educational modernization. In today’s “Internet+” education information era, online teaching modes have been known gradually. Online education has been widely used as breaking the spatio-temporal limitations and offering one of the best ways in public education [1]. Blended teaching can offer a continuous and innovative way for classroom teaching reform, gradually merge and replace the traditional teaching approaches [2]. Learning methods such as task-driven, case-based, and problem-oriented are widely applied in blended teaching. It is regarded as students-centered teaching method to carry out online and offline interactive teaching, which has a positive effect on stimulating students’ interest in learning and mobilizing students’ learning initiative [3].

Vocational education in engineering is associated with theoretical and practical knowledge, where students are obligated to go beyond the conceptual understanding of theoretical knowledge and to acquire practical skills. Different technical means, incentive measures and comprehensive application methods are flexibly used to realize the optimization of blended teaching for different courses. In this paper, taking the building intelligent engineering technology specialty as an example, multimodal fusion blended teaching and a variety of teaching management mechanisms are implemented in the professional courses. Through the teaching practice and exploration in a “classroom revolution” of online teaching, the teaching experience and achievements are accumulated, which offers a referred scheme for the reform and innovation of blending teaching courses.

## 2 Teaching Scheme Design

In view of the characteristics of talent training for building intelligent engineering technology professionals, curriculum design ideas in each professional course are adopted by combining theory, experiment and practical training, combining teaching contents with engineering cases, and combining group learning contents with job tasks. Various applications and platforms ranging from online education platforms to additional resource are employed. Multimodal fusion blended teaching for intelligent building engineering technology specialty is designed as a whole from the teaching objectives, content, organization and evaluation, as shown in Fig. 1. The teaching design should be conformed to the characteristics and requirements of online teaching to ensure the feasibility of implementing multimodal fusion blended teaching in the professional courses.

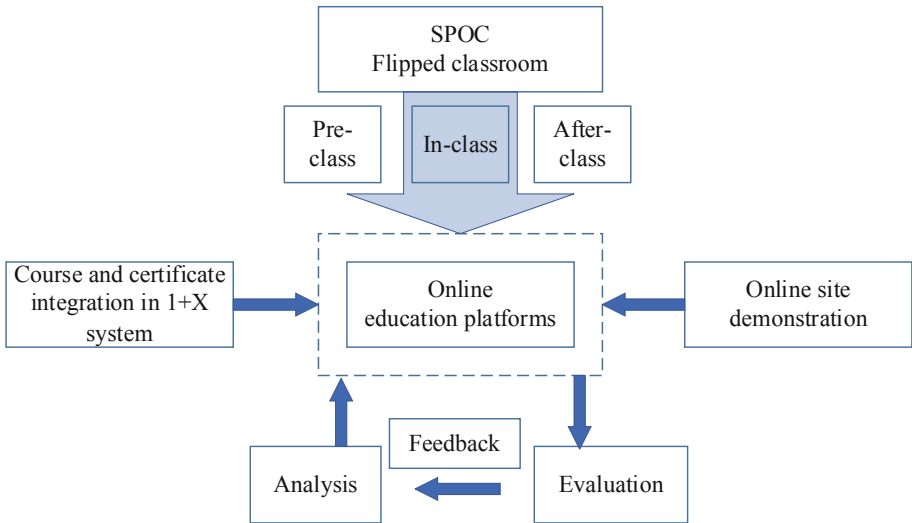


Fig. 1. Multimodal fusion blended learning design system.

## 2.1 Teaching Objectives

The specialty of building intelligent engineering technology mainly cultivates high-quality technical talents engaged in fire engineering, security engineering, communication and generic cabling engineering, intelligent building equipment monitoring system, building power supply and distribution system design, construction, detection, operation, maintenance, etc. [4]. The teaching of these specialty courses focuses on the cultivation of students' engineering technology practice ability and innovation ability. Through blended teaching, the professional teaching process and teaching quality are guaranteed. It also cultivates students' ability to learn independently and assisted in learning for the information society and the intelligent age, as well as the sense of innovation.

## 2.2 Teaching Content

The specialty courses mainly include architectural engineering drawing, information system and generic cabling, security system engineering, Building Information Modeling (BIM) Technology and engineering, electrical control and Programming Logic Control (PLC), building electrical equipment monitoring system, comprehensive training, enterprise order-oriented training, apprenticeship class training course, etc., and involve elective courses for teaching different administrative classes and mixed classes. According to the requirements of online and offline courses, the teaching content of related courses are reconstructed, which focuses on the basic knowledge and skills of engineering application, and integrate new technology, new process and new specification into the course or course module. Each professional course carries out task driven teaching around the typical case engineering projects. Learning tasks are range from easy to difficult and simple to complex, so that students can be full of enthusiasm for learning tasks and keep maintaining interest in learning. The theory involved in professional courses should not only be connected with reality, but also emphasize its practicality, set up more enlightening questions, and cultivate students' ability to solve practical problems.

In terms of teaching and learning resources, the curriculum resources of the specialty teaching resource library are fully used, and the digital teaching resources suitable for student's self-learning are reorganized to ensure a clear organizational structure. Each course provides rich and diverse development resources, which enable hierarchical teaching implementations. In addition to the simultaneous use of digital teaching resources for each course, the resources need to be updated, enriched, optimized and improved continuously. In general, teaching courseware, micro-lecture videos, engineering cases, excellent works, expanding practice and other learning materials are provided in the project as a unit to upload to the online learning platform, which is fragmented learning resources linking up to students' personal learning space and mobile learning terminal. The contents of teaching courseware and the micro-lecture video are synergistic and complementary to each other, covering the knowledge system and skill operation. When using the technology application software platform and virtual reality simulation experiment software platform to carry out teaching tasks, we should pay attention to the operating procedures of the post as the requirements of teaching standards, and guide students to complete each experiment and practical task. Rich and diverse resources for development are provided for each course, which is benefit for teaching students at different levels.

### 2.3 Teaching Organization

The teaching group is composed of teachers, enterprise tutors and technical support personnel of learning platform to jointly carry out curriculum structure optimization, curriculum content reconstruction, teaching progress management, digital resource construction, curriculum assessment, and learning platform data analysis. The teaching is carried out in accordance with the teaching plan to ensure the teaching order of all courses. Each professional core course combined with the curriculum knowledge structure system and the needs of course teaching is implemented in 4 consecutive sessions as one lesson at one time, which carry out teaching modes such as flipped classrooms, integration of course and 1+X certificate of vocational skill level, and connection engineering on-site “presentation”.

Online and offline learning tasks are covered on the pre-class, in-class, and after-class, and guide students to realize the importance of mastering the initiative in learning and realize self-learning throughout the entire learning process. For pre-class, students are motivated by task-driven learning, including video log for learning outcomes, questioning, online seminars, questionnaire surveys, and assessments, so that students would be interested in learning. For in-class, tasks are divided according to job roles, each student is involved in the task, and the learning tasks are completed in groups. In addition, during online live teaching. Various interactive activities such as achievement display, task report, problem discussion and troubleshooting are carried out to promote students’ knowledge application and technical skill improvement, so that they can harvest learning achievements. For after-class, through guiding students to complete homework and try to expand the task, strengthen the ability of comprehensive use of knowledge, improve the ability of innovation and practice, let students get the sense of achievement.

### 2.4 Teaching Evaluation

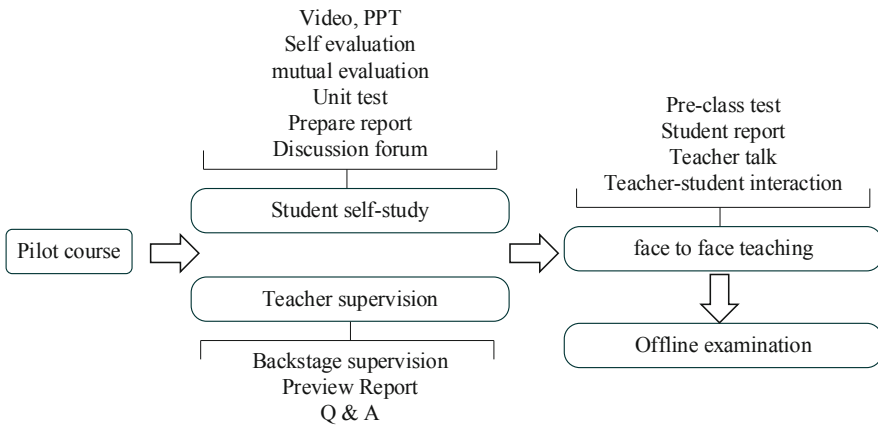
We realize the importance of online and offline learning through the whole learning process. Hence, assessment criteria must be clear for students. Teaching assessment focuses on the learning process. It is composed of online learning, group work task completion, learning achievement, learning attitude, learning ability, online assessment at the end of the term, which is multi-faceted, multi-angled and diversified assessments. The process assessment of each course accounts for 60% of the total score. Self-evaluation and inter group evaluation are included in the assessment. The proportion of online assessment at the end of the term is 40%. Part of the courses are set up with a comprehensive project of personalized and differentiated assessment content as the final exam content, which is completed and submitted within the time required online or offline. The teaching process can be tracked effectively by using information collection tools such as survey, test and check-in, which can feedback assessment information effectively and continuously improve teaching based on the feedback information.

## 3 Multimodal Fusion Blended Teaching Practices

### 3.1 SPOC Combing with Flipped Classroom Scheme

The blended teaching model based on flipped classroom breaks the traditional teaching restrictions, which is no longer subject to the limitations of time and space. Teachers

and students can build dynamic classrooms together and change the classroom form [5]. Each professional course group offers Small Private Online Course (SPOC) courses through online platforms such as Chaoxing Learning, Wisdom Vocational Education, Wisdom Tree, etc. It mainly guides students to complete learning tasks through the platform’s notification, sign-in, discussion, and supervision functions, and also uses information communication tools such as WeChat and QQ to assist communication, live broadcast and offline learning activities. In order to avoid network congestion, live teaching is carried out according to different teaching time, and different live platforms are used, such as Tencent Classroom, ZOOM, DingTalk, etc. Additionally, teachers use the online platform to manage course progress, classes management, coursework, exams, materials, discussion, Q&A, notification and course statistics. Instructor characteristics and facilitating conditions will positively influence students’ perceived accomplishment and enjoyment in the blended class [6]. Implementation diagram of SPOC combing with flipped classroom scheme is shown in Fig. 2.



**Fig. 2.** Implementation diagram of SPOC combing with flipped classroom scheme

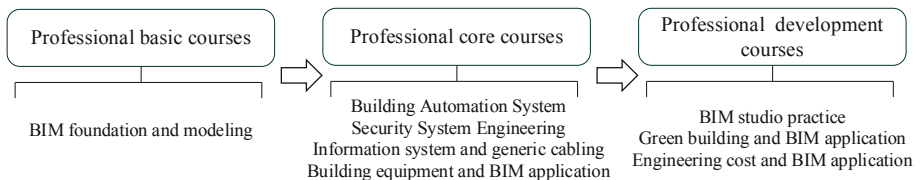
Each specialty course group arranges learning tasks in the platform, and issues a notice at least one day before each class, which guides students to study and explore independently, and consult reference books, engineering technical standards and specifications and other materials before the class. Every online classroom is carried out a variety of teaching activities, such as sign-in, voting, discussion, quiz, group confrontation, brain-storming, questionnaire survey, etc. According to the actual teaching situation in the online classroom, the teacher controls and adjusts the teaching progress, and require students following the working list to complete the learning tasks. Live broadcast setting up at each lesson is required more than 1/6 of the total time for the course. Teachers collect students’ questions before launching each live class, and assist students to solve the difficulties and problems encountered in self-study before the class. During the live broadcast, the teacher explains the important points and difficulties, and discusses the outstanding issues in the discussion posts. They also analyze some typical problems comprehensively and sort out the knowledge points. In order to strengthen the

interaction and communication with students, the teachers demonstrate good preview results for pre-class, excellent projects and creative designs. This helps students to gain the sense of achievement from self-learning. To gain deeper understanding and refine the students' lack of knowledge, the teachers carry out discussion along with the students. The teachers also provide question and answer session to engage the students and solve their learning problems.

Offline communication and discussion are mainly based on the way of creating discussion posts on the online platform, which helps teachers and students to participate and interact together, and also facilitates teachers and students to consult the discussion results at any time. The teachers then give personal feedback on the students' works. The feedback is meant to help the students to progress in their learning personally. Learning outcomes can be evaluated from online study assignments, coursework, extra project task and online test in an all-round way. Students living situation and network condition are also considered, the completion deadline of each online study assignment are allowed to extend for students to complete their learning tasks independently and ensure the quality of learning.

### 3.2 Integration of Course and 1+X Certificate of Vocational Skill Level

The essential characteristic of vocational education is to train students' professional skill. In the pilot work of implementing the national 1+X certificate of vocational skill level, higher vocational colleges become the main force of pilot work [7, 8]. Intelligent building engineering technology specialty in Dongguan Polytechnic is a pilot specialty of this 1+X certificate system, which is corresponding to the BIM professional skill level certificate. In the pilot work of implementing the 1+X certificate system, we should promote the integration of course and 1+X certificate of vocational skill level vigorously. The knowledge system and teaching content are reconstructed through the teaching reform at intelligent building engineering technology specialty, and the professional knowledge teaching is combined with the training of BIM application ability, as shown in Fig. 3.



**Fig. 3.** Integration of course and 1+X certificate of vocational skill level for intelligent building engineering technology specialty

The course of BIM Technology and engineering in the building intelligent engineering technology specialty accurately points to the knowledge goal, ability goal and quality goal of BIM vocational skill level (construction equipment section). Hence, the teaching content of this course is reorganized. Each learning project is connected with the requirements of professional skill levels to ensure that all learning projects cover the

advanced and optimized building equipment modeling, systematic analysis, engineering construction simulation, result output, and comprehensive project practice knowledge and skills. The course group refine the BIM learning content and operation process according to job task requirement, and record micro-lecture videos based on each job task assignment. Before each lesson, teachers upload micro-lecture videos and other teaching materials to the online platform, and post the notification of the learning tasks and homework requirements for this lesson. During the live class, teaching activities are mainly carried out around the important and difficult points of the project and the Q&A links. For individual error-prone and difficult-to-understand technical operations, the teacher makes practical demonstrations repeatedly and introduces some error demonstrations to deepen students' understanding. After class, students are required to record the whole process of BIM design platform operation in groups, and describe each operation step for the coursework. These methods improve students' operation proficiency, practice their oral expression skills and improve professionalism.

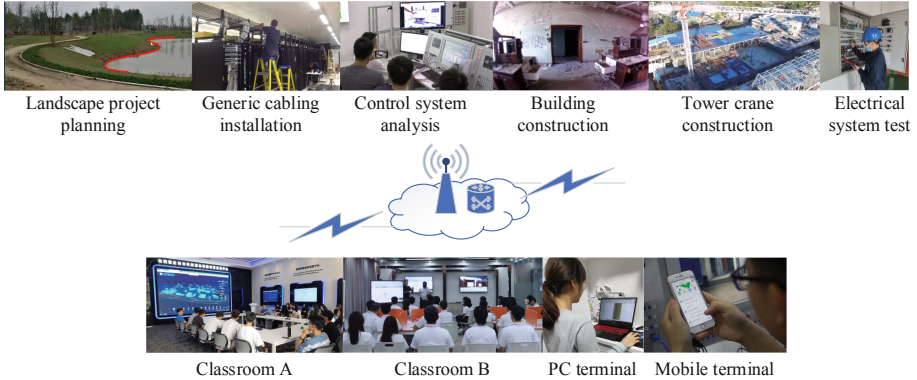
In addition, the comprehensive practical project of the original teaching plan is based on the real campus scene to restore all the campus building by BIM design. This teaching project can be taken for make the house where student lived as the BIM objects instead, and they need to complete the models of civil engineering, water supply and drainage, electric lighting and other models step by step, so as to "restore" their home.

BIM technology is covered in the teaching of professional core courses with comprehensive BIM application so as to realize integration of course and 1+X certificate of vocational skill level. This technology can be used to create building civil engineering and building equipment models for teaching projects of various core courses. The performance of project details and internal description are realized by BIM, which offers three-dimensional visualization effect. This can help students to increase the authenticity and experience of the overall building electrical equipment, and understand the knowledge and technical application of related courses more easily. The BIM model enables teachers to effectively explain the system structure, equipment principles and construction process of the project in online teaching. For senior students who had learned BIM technology, they are required to have further design of the BIM model using in other courses, or create a new BIM model based on the needs of other teaching project. For example, BIM model for generic cabling is used in building generic cabling teaching project of information system and generic cabling course. BIM model for weak current system is used in security monitoring project of security system engineering course. BIM model for Heating, Ventilation and Air Conditioning (HVAC) is used in central air conditioning teaching project of building equipment monitoring system course. By using the above methods, the application of BIM Technology is fully integrated into the professional core courses, hence consolidating and improving students' application ability of BIM Technology, and promoting their mastery, expansion and deepening of professional knowledge.

### **3.3 Project Site Online Demonstration**

We carry out project site for teaching activities by connecting on-site engineering demonstration. In the live broadcast class, alumni working at the engineering site are invited to introduce the on-site equipment functions, engineering applications, and engineering

project conditions, as shown in Fig. 4. Let student to understand different project scenes and the application of system equipment on different projects. They also make a deep impression for the contrast between classroom learning and work practice.



**Fig. 4.** Project site online demonstration

Due to the needs of epidemic prevention and control, there were a significant increase in engineering projects for installing access control and surveillance cameras with human temperature measurement functions in public places. The alumni at the project site explained the basic functions and principles of these devices to students in the way of mobile phone remote video communication, so that the online learning students could understand the monitoring equipment based on thermal imaging human body temperature screening technology, and make them realized the key role of building intelligent technology in epidemic prevention and control.

Some alumni work in facility operation and maintenance and management positions in residential communities and technology industrial parks. During the epidemic, they stuck to their posts, and returned to project positions on new year holidays, insisted on daily inspections of sites in their jurisdictions, routine inspection and maintenance of intelligent building equipment, such as building power supply and distribution systems, central air conditioning systems, fire linkage system, water supply and drainage control system, video surveillance system, entrance and exit access control system, parking lot system, group control elevator system, etc. Through on-site connection, alumni explained and analyzed the on-site cases including the actual situation encountered problems at work and the corresponding solutions, so that students realized that the knowledge and technology learned from the professional core course were so important to the application of engineering. For example: checking the operation of water pump when the water supply is insufficient in the residential area, checking the circuit and maintenance monitoring when the monitoring is off-line in rainy days, making preparation of the operation for the central air conditioning ventilation system according to the specific guidelines for epidemic prevention, etc. In addition, through the platform, we could

share some excellent reports evaluation online from the current and previous internships students, so that they could understand the internship experience and gain from senior students, and learn how to make a correct outlook on career.

## 4 Teaching Effect and Reflection

### 4.1 Summary of Successful Experience

Through the teachers' design of online teaching content and interactive links, the traditional teaching methods of teachers and students have been changed, and the enthusiasm of teachers to teach and students to study seriously has been fully aroused by diversified online teaching. We design online teaching content and interactive activities attentively to offer diversified online teaching modes, which fully aroused the enthusiasm of teachers in teaching and students in learning seriously, as shown in Table 1. Each course group focuses on teaching effects and try their best restore online teaching to face-to-face teaching. Through the application of BIM technology, the construction of digital building and equipment models helps students to understand the knowledge that they learn in different scenarios of professional core courses. This method also solves the problem that students could not learn in the working scene and implement integration of course and 1+X certificate of vocational skill level effectively. The teaching method of project site online demonstration provides students with learning cases that are closest to the actual working situation. The above measures effectively promote the implementation of online flipped classroom. On the basis of the investigation and analysis, students' learning willingness and test scores have been greatly improved, and the employment satisfaction of enterprises has been significantly improved after the practice of the proposed multimodal fusion blended teaching, as shown in Fig. 5.

**Table 1.** Statistics of blended teaching activities in an academic term

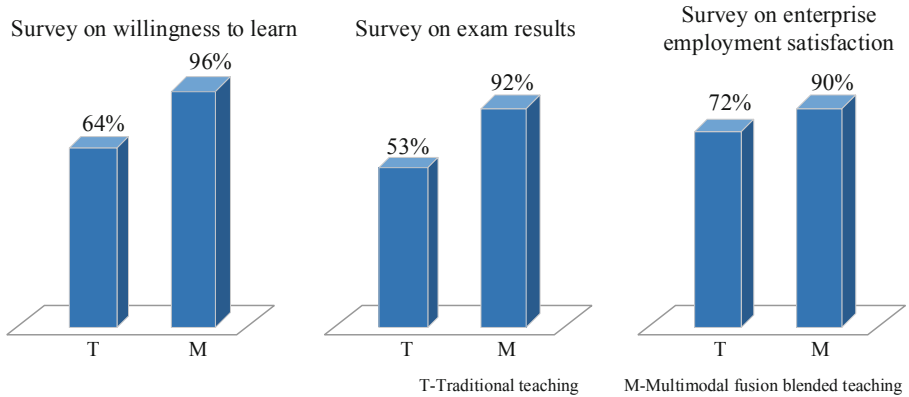
Time	Teacher activities	Student activities	Attendances	Video watch	Discussions	Tools
Pre-class	Course design Platform preparation Task assignment	self-learning self-learning Discussion	100%	66%	29%	<sup>a</sup> MT 23% PC 77%
In-class	Discussion Answer question Demonstration Problem solving Difficulty analysis	Discussion Asking question Virtual labs Task report Online test	100%	5%	41%	MT 2% PC 98%

(continued)

**Table 1.** (continued)

Time	Teacher activities	Student activities	Attendances	Video watch	Discussions	Tools
After-class	Survey Evaluation Course analysis	Coursework Extra task Discussion	100%	29%	30%	MT 16% PC 84%

<sup>a</sup>MT-Mobile Terminal, PC- Personal computer



**Fig. 5.** Surveys of teaching effectiveness for multimodal fusion blended learning

**4.2 Analysis of Deficiencies**

Although the teaching activities are on the right track by the implementation of online flipped classroom, there are still some problems and deficiencies. At the professional level, the course group needs to strengthen communication, fully exchange their respective teaching experience, comprehensively use various platform tools, and listen to the opinions of teaching supervisors and student feedback. The most difficult problem for online teaching is how to monitor the actual learning effects of students. This needs to strengthen the contact with students, especially for some individual students who have needs or difficulties. Some students find difficulties in having communication and interaction with teachers in online learning environment. Teachers are demanded to provide individual tutoring, so as to customize teaching to deal with students' individual differences. Therefore, we collect feedback information from students in different ways, such as questionnaires, discussions, reports, tests, etc. According to the feedback, we summary learning tasks and sort out their knowledge problems in time, then adjust the online teaching method, live broadcast duration and learning task arrangement appropriately. We realize that it is so important for teachers to have guidance, inspiration and supervision in the online teaching process to encourage students to learn independently and help students solve learning problems by themselves. Some core courses or course modules are subjected to use hardware equipment to carry out practical training, which

result in limitations to the teaching content. It is difficult to complete all the courses online.

By summarizing the gains and losses in the process of teaching implementation, we need humanized teaching management and focus on the effectiveness of the teaching process and ensure the participation rate and completion of students' online learning. Course management, communication and interaction are the key factors affecting student study. Teachers are encouraged to have active participation in exploring technology for multimodal fusion blended teaching. The challenges encountered will inspire teachers to be reflective, open, creative, and adaptive to dynamic changes.

## **5 Thoughts on the Reform of Blended Teaching in Education Information Age**

### **5.1 Complementation of Online and Offline Classroom Teaching**

It becomes a new challenge to teach students with low cognition and various learning style in online learning environment. In the era of educational information, facing the changes and demands brought about by the "new normal" of large-scale online teaching, it is necessary to explore new practices of online and offline hybrid teaching and form a new paradigm of online teaching. Through the synergy and complementarity of online and offline teaching, the students who teach the class are reasonably allocated online and offline learning tasks, and students' personal learning space is built. By combining the advantages of face-to-face teaching, online interaction, and digital teaching, we have vigorously promoted the hybrid teaching model in some professional core courses to better improve teaching quality.

### **5.2 Deep Integration of Information Technology and Education**

Information technology has promoted the acceleration of education informatization. It cultivates a new ecology of education and teaching, and poses more challenges to the integration of modern educational technology and educational content. With the development of AI, 5G technology, virtual reality and real-time interactive teaching modes will be rapidly applied [9], and more and more cutting-edge information methods will be used to assist teaching [10]. It is a good time for blended teaching to cultivate students' learning habits in this information era, and comprehensively enhance students' independent learning ability and practical ability for the informatic society. Meanwhile, higher requirements are put forward for teachers' information technology application ability, such as "Internet+" teaching skills, "AI+" teaching mode [11]. Through demonstrations, competitions, training and other practical methods, teachers will comprehensively be improved their ability to control blended teaching design and teaching process, so that the innovative application of teachers in informatization teaching will become an inexhaustible driving force for teaching reform. In addition, we should continue to develop and apply high-quality digital teaching resources, deeply integrate modern information technology into the whole process of education and teaching, couple with a long-term teaching information management mechanism, and promote the healthy development of education informatization.

### 5.3 Integration of Ideological and Political Theories Teaching and Blended Teaching

The ideological and political education of curriculum is new requirement of strengthening the ideological and political work for higher education in China in the new era [12]. Integrating the ideological and political education into all courses can effectively stimulate students' learning motivation and promote the generation of learning objectives. Ideological and political theories teaching in all courses is systematic project [13]. For the ideological and political education of professional courses, we need to maintain the content and characteristics of professional courses, and implement the professionalism, craftsmanship and professional spirit into the classroom. The ideological and political elements in professional courses already exist, and they need to be further explored, sorted, brought into play, and integrated into all aspects of teaching class. Teachers of professional courses need to deepen the logic and methods of ideological and political practice in professional courses. In the above-mentioned blended teaching of building intelligent engineering technology professional courses, the engineering technology case set of project site online demonstration can be reconstructed into the ideological and political elements of professional courses. The cases of body temperature monitoring, access control and camera technology application during the epidemic period are good examples to cultivate students' scientific outlook and make them feel the significance of actively participating in science and technology. The alumni persisting in their posts in facility operation and management is one of the anti-epidemic cases, which can tell students their professional performance in sticking to ordinary jobs, and take their responsibilities to deliver positive energy. The whole set of special teaching cases during the epidemic period can be formed into a set of ideological and political cases, and the professional knowledge and the relevant stories are combined to ignite the students' patriotic enthusiasm and struggle spirit. In the specialty courses, we guide students to perceive these stories systematically, and encourage the students to learn the internal motivation, and make the specialty courses truly achieve the effect of education.

## 6 Conclusions

Multimodal fusion blended teaching is introduced in this study. In the proposed teaching activities, the interaction for teacher-student and student-student are increased significantly. Students, alumni and teachers participated in the discussion, which stimulates students' great learning enthusiasm and achieved good learning effect. The comprehensive implementation of blended teaching in colleges and universities across the country provides practical confidence in the reform of education informatization, which provides an opportunity for exploration of blended teaching reform and innovation and integration. Facing the new ecology of "Internet+" education and teaching in the era of education informatization, higher education needs to be bold in trying to innovate, promote the reform of learning methods, and create a new hybrid teaching model. Continuously explore and advance in the direction of reform and innovation of the in-depth integration of information technology and education and teaching, implement information technology to the entire process of teaching and educating, comprehensively

improve the quality of training technical skills, and provide a strong driving force for the innovation and development of higher education.

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