Blended Learning Reform of Virtual Instrument Technology Course Based on CDIO Concept

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Abstract. In the background of new engineering construction, we focus on cultivating students' practical ability, innovation ability and comprehensive quality ability, and combine the current situation and problems faced by the practical courses of engineering majors in our university. In this paper, we analyze the problems of the course and the defects of the traditional teaching mode, introduce the online and offline hybrid teaching mode and the CDIO concept into the theoretical and practical teaching of the course, carry out the teaching reform with the concept of student-centered and teacher-led, and strengthen the process and project assessment. It is proved that the teaching reform has effectively improved the learning effect and practical innovation ability of students.

Keywords: CDIO · virtual instrument technology · blended learning

1 Introduction

Virtual instrumentation technology is the use of high-performance modular hardware, combined with efficient and flexible software to complete a variety of test, measurement and automation applications [1]. The basic idea is to use software instead of hardware as much as possible in the design of test systems or instruments. The virtual instrumentation technology course integrates measurement technology, computer technology, signal processing technology, software technology and other disciplines into one, and is a major course with strong practicality in automation. In the past, when we organized the teaching of this course, the classroom is mainly based on the "duck-fill" teaching method, and this traditional teaching method in the course of teaching students' engineering practice and innovation ability is not well exercised, the actual teaching effect is not good. As an application-oriented undergraduate institution, our university attaches great importance to the cultivation of students' engineering project ability. In order to respond to the demand for automation talents in industrial transformation and upgrading, and to cultivate application-oriented talents to meet the needs of enterprises, it is imperative to carry out online and offline hybrid teaching reform for this course in combination with CDIO engineering education concept [2]. On-line and off-line hybrid teaching is to combine the advantages of traditional learning methods and online learning resources with each other to obtain better teaching effects [3]. This paper takes online and offline blended teaching as the guide, project-driven teaching content as the guide, a series of

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reforms in teaching mode, teaching design, teaching operation, assessment and evaluation, etc., to realize the student-centered and teacher-led teaching requirements, and give full play to the autonomy of teachers and students to improve the initiative, enthusiasm and creativity of students' learning.

2 Virtual Instrumentation Technology Course Characteristics and Pre-reform Status

Virtual instrument technology is equivalent to adding a set of software and hardware to a general computer. When the user operates this computer, it is like operating a special electronic instrument designed by himself, which can conveniently and flexibly complete the acquisition, analysis, display and data storage of the measured data. In virtual instrument system, hardware only solves the input and output of signals, and software is the key of the whole instrument system. Any user can easily change, increase or decrease the function and scale of the system by modifying the software, so there is a saying that "software is instrument" [4]. The design and implementation of virtual instrument system are to determine the hardware and software programming respectively. The software programming includes I/O interface instrument driver, VI function design, and virtual panel function programming. Therefore, this course is arranged in the computer room, and the mainstream LabVIEW programming software is used as the teaching software.

Virtual instrument system consists of hardware platform and software platform respectively. Its hardware platform includes computer (PC, workstation) I/O interface devices (PC-DAQ, GPIB instrument, serial instrument, VXI module, PXI module). The platform includes special software tools (LabVIEW, VEE). The hardware composition of the platform is shown in the following Fig. 1.

Before the reform, our university offered 32 h of virtual instrument technology courses, including 22 h of theory and 10 h of experiment. Because the teachers of theory and experiment courses are often different, the education concept is not unified and the teaching method is relatively traditional, so there are often problems such as theory and experiment courses are separate, teaching content is disconnected, teaching interface does not correspond, which seriously affects the teaching quality and students' mastery of the corresponding knowledge.

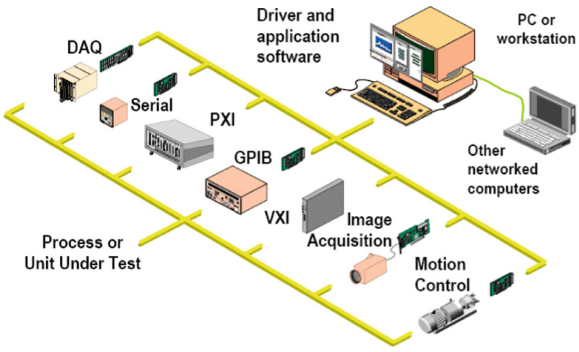

Fig. 1. Virtual instrument system hardware composition diagram

3 Shortcomings of Pre-reform Teaching

3.1 Single Teaching Method

Theoretical teaching adopts a "duck-fill" approach, and experimental teaching is based on teacher demonstration and student repetitive operation. The teacher-centered teaching method ignores the teacher's personalized guidance, while students passively receive knowledge, and their autonomy and enthusiasm for learning are relatively low, which makes it difficult for students to improve their ability to solve practical engineering problems and teamwork. At the same time, due to the differences between students' knowledge base and learning ability, teachers need to adopt various teaching methods and teaching means to truly realize the all-round training of students' knowledge, ability and quality.

3.2 Teaching Content is Too Theoretical

The automation major of the School of Mechanical and Electrical Engineering of our university has offered a 32-h course on virtual instrument technology since 2018, and the mainstream virtual instrument programming software LabVIEW is selected as the teaching software. Since the teaching of this course is based on LabVIEW programming operation, which is very practical, and the mainstream LabVIEW textbook introduces LabVIEW-related concepts and methods in great detail, with more conceptual knowledge and detailed knowledge, students who have just come into contact with it often cannot grasp the key points of learning. The course contents are scattered, and the chapters are relatively independent and lack of continuity; engineering application examples are rarely involved. There are several outstanding problems such as theoretical detachment from practice, weak practical links, and disconnection between industry and academia, which seriously affect the initiative and enthusiasm of students' learning.

3.3 Online Resources Do not Match the Teaching Content

During the COVID-19 epidemic, in order to carry out online teaching, there are a lot of high-quality massive open online course resources on the platforms of MOOC and Superstar Fanya of China University for everyone to use for free. However, when promoting or introducing online education from other places, there is a problem that the content can't be effectively connected with the existing curriculum content, resulting in unreasonable arrangement of credits and hours, which makes online education unable to organically combine with traditional teaching.

3.4 Course Examination is Unscientific

The course assessment adopts summative evaluation, without process assessment link. The theoretical assessment content is biased towards memorized knowledge assessment, comprehensive design questions are few, and the experimental assessment only pays attention to experimental results, which leads to poor comprehensive analysis and problem solving ability of students.

4 Course Teaching Reform

This paper takes the virtual instrument course of automation in Guangzhou Huali College as the research object, and puts forward the teaching reform plan for some shortcomings in theoretical teaching and practical teaching, hoping that the teaching reform can better serve the goal of talent training, help students better master the professional knowledge, and also lay a good foundation for the development and employment of students after graduation.

4.1 Reform of Teaching Methods

With CDIO concept as the guide, we propose project-driven teaching to focus on the cultivation of students' engineering project ability. We deeply integrate Internet information technology with teaching, develop virtual instrument engineering projects based on CDIO, and carry out the construction of online teaching platform. Students learn engineering projects and practice them on the online platform, while offline students and teachers communicate, discuss projects, defend, test and experiment hardware, etc. The teaching objectives and contents of both online and offline teaching links are complementary and integrated, forming an integrated teaching system.

4.2 Optimization of Teaching Content

Optimize and adjust teaching contents, develop virtual instrument engineering projects based on project education and learning, and integrate LabVIEW software operation methods, programming skills and virtual instrument design ideas into the projects. Project design is divided into two types according to hierarchy and progressiveness: mini-projects and comprehensive projects. The small projects focus on basic programming applications, starting from small virtual instruments, which are easy to implement and conducive to mastering corresponding basic knowledge and laying the foundation for completing comprehensive projects in the next step. Comprehensive projects are selected for tasks that are more closely related to engineering practice and require the design of more complex virtual instruments by integrating knowledge points from several teaching units. From shallow to deep, interspersed with small projects and integrated projects, engineering combined, learning and doing, so that "teaching and learning" organically combined. With the project as the driving force, students can quickly master the corresponding knowledge points and improve the engineering practice ability.

4.3 Construction of Online Teaching Platform

At present, thirteen teaching videos have been developed for this course and uploaded to SuperStar Learning Platform. On this basis, we will develop comprehensive project videos and hardware experiment videos according to the CDIO concept. At the same time, we give full play to the advantages of rich Internet resources and introduce excellent virtual instrument engineering project resources online. The network teaching platform is built, which contains these self-built and introduced teaching resources. Relying on the

Internet, teachers lay out project tasks online, students learn and practice independently online anytime and anywhere, and teachers and students interact, answer questions and provide counseling through the teaching platform way. Students upload their projects to the teaching platform after completing them, and teachers evaluate and give feedback.

4.4 Optimization of Course Assessment

The original assessment method of final exam + usual performance is changed to a combination of multiple assessment methods. By improving the assessment of teaching process and project practice effect, the multi-faceted and scientific nature of the evaluation is improved, and students are prompted to discover their own problems and adjust them at the first time. And also to a large extent to improve the quality of teaching, fundamentally promote the scientific and complete development of teaching evaluation and assessment management. The specific assessment methods include. First, personal learning data and evaluation results derived from online teaching superstar learning platform; Second, the process performance scores of offline classroom tests and hardware experiments; Third, the results of group project completion and defense; The fourth is the usual attendance score.

5 Teaching Project Design and Project Implementation

The course is organized based on project-driven teaching and learning with problems to finally realize the integration of "teaching, learning and doing", so as to improve the students' engineering practice ability [5]. The teaching mode adopts online and offline mixed teaching. The online teaching relies on Super Star Learning Platform, and the course content is updated according to the progress of the project, and the online platform mainly completes the learning of theoretical knowledge. The online course and offline course are interspersed. The teaching process of the course is divided into three stages in chronological order: before, during and after class, and each stage is carried out in a cycle. The teaching arrangement of each stage is shown in Table 1.

The mini-projects are based on basic programming applications, starting from small virtual instruments, which are easy to achieve the teaching objectives and stimulate students' learning enthusiasm, and at the same time are conducive to mastering the basic knowledge of the course and laying the foundation for completing the comprehensive project in the next step. The integrated project selects tasks that are closely related to life practice and engineering practice, and requires the integration of knowledge points from several teaching units to design more complex virtual instruments. From shallow to deep, interspersed with small-scale projects and integrated projects, the combination of theory and reality, learning and doing, so that the "teaching and learning" organic combination. The specific division of teaching contents and projects is shown in the following Table 2.

Examples of small projects and comprehensive projects created based on LabVIEW are shown in Fig. 2 and Fig. 3 below, respectively.

Table 1. Blended teaching arrangement

Time	Teaching platform	Content	Teaching methods
Before Class	Learning platform	Watch the video	Online teaching
		Publish task	
In class	Theory teaching	Theoretical knowledge	Offline teaching
	Experimental teaching	Project experiment	
After class	Learning platform	Homework	Online teaching
		Summary Exchange	

Table 2. Example of project division

Teaching content	Teaching Program	Core points	Project Type
Graphic interface	User menu design	Interactive interface	Small Projects
	Oscilloscope	Three chart modes	
	Measuring temperature and volume	Establish VI	Integrated project
Data acquisition	Analog signal acquisition	Analog signal input and output	Small Projects
	Digital signal acquisition	Digital signal input and output	
	CO_2 concentration detection	System data acquisition	Integrated project

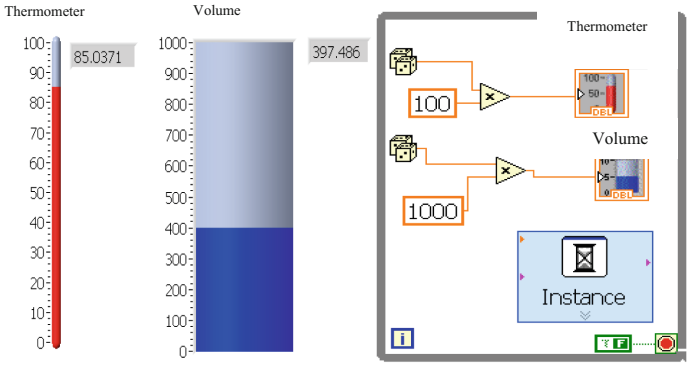

Fig. 2. VI Front panel of interface (left) Back panel of flow chart (right)

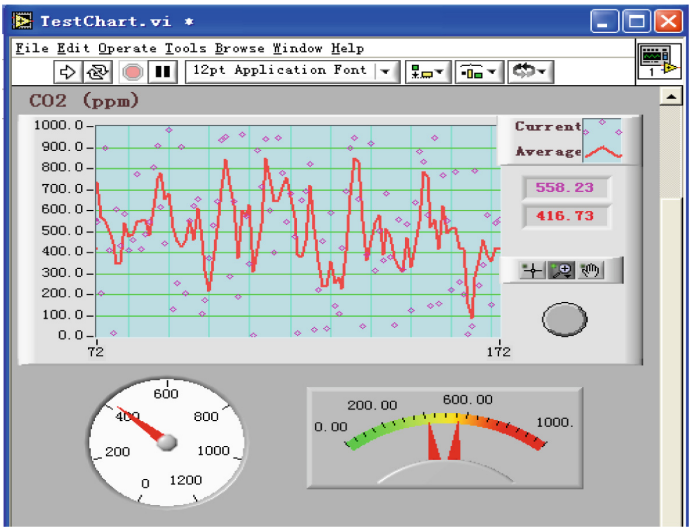

Fig. 3. Integrated project VI CO_2 detection display interface

6 Teaching Reform Effect and Feedback

At the end of the course, anonymous survey was conducted in the form of questionnaires, which covered whether the teaching of CDIO concept was acceptable compared with the traditional teaching method; the difficulty level of project setting; students' attitude when completing the project, individual participation in the group, teamwork ability of the group; the gain, interest and sense of achievement of the course learning. Satisfaction with the course teaching and other multifaceted issues, as far as possible to objectively reflect the facts. Through the statistical analysis of the questionnaire results, we can see that: First, more than 95% of the students are satisfied or very satisfied with the teaching reform of this course; Second, CDIO concept project teaching method subdivides the project, so that students can quickly get started and complete the project with clear goals, which improves students' ability to solve practical problems; Third, through online and offline mixed teaching, the whole process assessment is strengthened to effectively stimulate students' subjective initiative; fourth, students' learning enthusiasm and sense of achievement are improved, and the team cooperation spirit among students is cultivated.

7 Conclusion

The course of virtual instrumentation technology has been reformed by the hybrid teaching based on CDIO concept. After the practice of hybrid teaching reform based on CDIO concept, the course has shown vigorous teaching vitality. Firstly, the educational concept of the reformed course is unified, advanced, scientific and easy to operate; secondly, the teaching objectives of the theory and experiment courses are closely related to the training objectives and enterprise needs, showing the significant characteristics of keeping up with the times; thirdly, the design and implementation of the teaching contents of the

theory and experiment courses not only take into account the integration of the course as a whole, but also reflect the differences in the teaching modules, no matter in the design and arrangement of the teaching contents, the integration and connection of the teaching hours, or the appropriate selection and implementation of the teaching methods. Whether in the design and arrangement of teaching contents, the coordination and articulation of teaching hours, or in the appropriate selection and flexible use of teaching methods, the students' learning conditions and learning characteristics are taken into account, which truly realizes the student-centered education concept; finally, the assessment, teaching evaluation and feedback of course teaching contents have multi-dimensional and diversified characteristics, which provide continuous motivation and optimization direction for the continuous improvement of course reform. The course teaching reform has mobilized students' enthusiasm and initiative in learning and improved students' ability to acquire knowledge, solve problems, work in teams and communicate, and the teaching mode can provide reference for other courses.

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References

1. Cao Liying, Wang yue, Li Chundong, Wang Fei, Discussion on Teaching Reform of Virtual Instrument Technology and Application Course Based on CDIO Concept [J].Science & Technology Information, 2022, 20(20): 173–176.
2. Chen Zhiling, Yang Hanning, On the Teaching Reform in CDIO Mode [J]. Science & Technology Vision, 2022, (20): 109-111.
3. Zhang Jin, Yang Zhen, Chen Qingquan, Luo Yazhong, Liang Yangang, The Online-offline Blended Teaching Reform—Taking Computational Methods Course as an Example [J]. Higher Education Journal, 2022, 8(30):142-145.
4. Fu SanLi, Wang Yuan, Huang Hengyi, Reform of teaching mode of virtual instrument technology course under the background of "three-dimensional" course construction [J]. Internet of Things Technology, 2020, 10(09):115-117.
5. Yang Shengyun, Zhao Wenlong, Wan Weiqiang, Qiu Yulan, Innovation-oriented Teaching Reform and Practice of LabVIEW Programming and Virtual Instrument Design Course [J]. Journal of Nanchang Hangkong University, 2021, 35(02):116-119.