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Exploration of Teaching Reform of "Automatic Test System" Course Based on CDIO Mode

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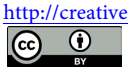


Abstract

Aiming at the problems that the traditional teaching process of "Automatic Test System" course is mainly based on the single teaching of theoretical knowledge, the practice teaching is separated from the engineering reality and the course evaluation is not reasonable, the reform exploration is carried out from the aspects of teachers' ability, teaching content and evaluation method, combined with the CDIO (Conceiving Designing Implementing and Operating) model and the project teaching concept. Focusing on the main line of "Automatic Test System" course, aiming at the needs of talent training, the course content is optimized into 7 teaching items. Taking the serial communication interface teaching project as an example, the teaching scheme combining theory and practice under CDIO mode and the assessment method focusing on the whole process of teaching and the integration of theory and practice are discussed.

Subject Areas

Mechanical Engineering

Keywords

Teaching Reform, Automatic Test Technology, CDIO Mode

1. Introduction

With the continuous improvement of complexity, integration and intelligence of modern manufacturing equipment, and the gradual development of modern instrument bus from GPIB, CAMAC and VXI bus to PXI and LXI bus [1], the upgrading of matching test equipment is also accelerated. As a result, various instruments coexist in the current test equipment, and special test equipment and general test equipment are used together, which seriously restricts the improve-

ment of the application ability of the equipment. This also puts forward higher requirements for the teaching of automatic testing system as the core and main course of testing related majors.

Through comprehensive analysis of the teaching reform effect of automatic testing technology course in recent years, it is found that there are mainly three problems: First of all, although the course syllabus formulation and teaching content can basically meet the needs of the post, the course teaching content is multi-covered, covering the serial communication interface (RS-232C/422/485), GPIB bus, VXI bus, PXI bus and LXI bus, system integration and software development and much other theoretical knowledge. Students can not master and digest this knowledge in a short time, resulting in students' learning enthusiasm is not high. Secondly, the teaching equipment equipped by the school is mostly outdated, and the practical knowledge learned by the students at school does not match the ability needs of the future positions, which leads to the unsatisfactory practical teaching effect [2]. Finally, teachers still generally pay attention to the inculcation of book knowledge and practical skills, ignoring the imparting of methods and means, which leads to the lack of students' ability to draw inferences by analogy and have little understanding of the new equipment, which weakens students' ability to hold posts [3].

In order to solve the above problems, the author actively explores the introduction of CDIO teaching mode in the teaching process, integrates the project driven concept, and tries to reform the teaching content and teaching mode of the "Automatic Test System" course, so as to organically combine theoretical knowledge, practical knowledge and specific post requirements, and comprehensively improve the professional knowledge and practical skills of students.

2. Analysis of Teaching Status

The traditional teaching methods of the course of automatic test technology generally focus on the course content, teaching objectives, and key and difficult points, from the basic concept of automatic test to simple serial communication interface (RS-232C/422/485) and parallel communication interface (GPIB bus), and then to VXI/PXI/LXI bus. When it comes to system integration and software development, the teaching content is set from simple to complex, and the teaching ideas are also very clear. However, due to too many knowledge points and abstract content, the learning effect is barely satisfactory.

As a teacher, it is necessary to deeply analyze the teaching objectives of this course and learn to empathize, that is, to think about the contents that students need to master in this course and the skills they must possess in future positions. Reverse thinking is based on the needs of students, through teaching the corresponding test equipment working principle, operation, test system construction steps and common fault analysis and elimination, layer-by-layer analysis, and crack one by one, stimulate students' interest in classroom learning, so as to improve the teaching effect.

The course "Automatic Test System" covers a wide range of teaching contents, including the basic theory of automatic test (such as test system body) system structure, measurement error, serial communication interface (RS-232/422/485), parallel communication bus (GPIB), VXI bus technology, LXI bus technology, PXI bus technology, software development technology, test instrument driver development and test system integration technology and anti-interference technology and much other theoretical knowledge. Through comprehensive analysis of the teaching effect of "Automatic Test System", the author found that there are mainly the following three problems.

1) Abstract theoretical knowledge is difficult to understand. The teaching content of the course covers a wide range of areas, and the basic concepts are numerous and highly abstract. Most students cannot master and digest them in a short time. Teachers often pay attention to the explanation and analysis of theoretical knowledge in the course of teaching, and cannot fully combine theoretical knowledge with practical operation, which leads to students' limited understanding of a certain knowledge point, and unable to understand and master the composition principle of the actual automatic testing system as a whole, students' practical ability and innovative thinking cannot be fully developed and exercised.

2) Practice teaching is divorced from engineering reality. The course "Automatic Test System" arranges 14 class hours of computer experiments, which combines theoretical knowledge with test equipment to a certain extent. However, the computer experiment of the course does not fully consider the situation of students' future positions and the cultivation of students' post abilities. This is due to the following reasons: First of all, the teaching equipment equipped by the school is mostly outdated, and the practical knowledge does not match the ability demand of the future position. Secondly, teachers still generally pay attention to the inculcation of book knowledge and practical skills, ignoring the cultivation of post ability and professional quality.

3) The course evaluation is not reasonable enough. The course "Automatic Test System" still adopts the traditional evaluation mode, which is teaching-centered, focuses on students' test scores and focuses on students' learning results, which is not conducive to comprehensive evaluation of students' ability. In order to evaluate the teaching effect of the course effectively and improve the training quality of students, it is necessary to adopt the evaluation method of integrating theory and practice, and bring the process and result into the assessment system. The results of computer experiment should not only examine the students' operation standardization, but also include the students' program design ability and comprehensive professional quality into the comprehensive assessment.

In order to solve the above problems, the author actively explores importing CDIO teaching mode in the teaching process, and at the same time into the project drive concept, the "Automatic Test System" course teaching content and

teaching mode reform attempts, make theoretical knowledge, practical knowledge and specific job position requirements organically, improve the students' professional knowledge and practical skills.

3. Teaching Exploration of "Automatic Test System" Course Based on CDIO Mode

The core of CDIO mode is a curriculum teaching idea that connects theory and practice and returns to engineering practice. It mainly adopts the teaching method of "learning by doing", taking specific engineering projects as the learning carrier, and teachers lead students to learn and practice in the conception, design, implementation and operation of the projects. In order to cultivate students' technical knowledge (including basic knowledge and professional knowledge), personal professional skills, teamwork ability and engineering ability [3] [4] [5], the author explores and practices the course of "Automatic Test System" from the aspects of teachers' ability, teaching content, assessment and evaluation.

3.1. Teaching System Based on CDIO Concept

CDIO represents the Conceive, Design, Implement, Operate and other steps in the project. The core idea of CDIO education is to promote the improvement of students' basic engineering knowledge, individual ability, team ability and engineering system ability through the implementation of projects.

CDIO includes three core documents: a vision, an outline, and 12 standards. Its vision provides students with an engineering education that emphasizes engineering foundations, based on the background environment of the concept-design-implementation-run (CDIO) process of real-world products and systems. Its outline for the first time expressed the basic engineering knowledge, personal ability, interpersonal team ability and the whole CDIO process ability that engineers must have in a step-by-step and detailed way so that the engineering education reform has a more clear direction and system. Its 12 criteria provide systematic and comprehensive guidance for the implementation and inspection of the whole model, which makes the reform of engineering education concrete, operable and measurable, and has important guiding significance for both students and teachers. CDIO embodies the unity of systematicness, scientificity and progressiveness, and represents the development trend of contemporary engineering education.

CDIO engineering education, in essence, is a reform of course teaching by using modern network information technology and engineering education concept. Based on the integration of theory and practice, the integration of multiple teaching scenarios and the optimization of teaching resources, the teaching reform of "Automatic Test System" has established a step practical teaching system guided by "engineering teaching content—blended teaching—course assessment system", so that students can truly learn by doing in learning.

3.2. Tamp the Foundation to Grasp the Main Line of the Curriculum

The knowledge points included in the course of automatic test technology include the architecture of automatic test system, measurement error, serial communication interface (RS-232C/422/485), GPIB bus, VXI bus technology, LXI bus technology, PXI bus technology, software development technology, test instrument driver development, test system integration technology and anti-interference Technology, the knowledge points involved are very much, the knowledge area is also very broad. When teaching the teaching content and operation, teachers should closely focus on the main line of the course, comb the knowledge points and build the knowledge scope. The explanation process should be from simple to complex, point and surface combination, layer by layer infiltration, one by one. "Emphasizing foundation, transferring method, practicing skill and combining theory and practice" are the basic principles throughout the course of automatic test technology. By laying points of interest in teaching links such as theoretical teaching and practical operation, strengthening comprehensive visual display and multi-angle case infiltration, the strength, breadth and depth of the combination of curriculum theory and practice can be further improved, so as to build a complete teaching system of automatic test technology.

3.3. Project-Based Training Focuses on Feedback and Evaluation

In order to make project-based teaching proceed smoothly, we must take students as the main body and teachers as the leading, further improve students' learning enthusiasm and give full play to their subjective initiative. Through the centralized discussion of core knowledge points, the use and operation of test equipment as the carrier, and interspersed in the theoretical teaching process, the active atmosphere of classroom teaching was created, and the students' interest in learning was enhanced, so that they could better analyze and solve problems, so as to achieve the teaching purpose of integrating knowledge and combining theory and practice. Since most students do not know much about the preparation process of test technology and are not familiar with the actual test equipment, it is necessary to highlight the subject position of students and strengthen the guidance of difficulty and ease. In order to better conduct the training, according to the pre-class investigation, according to the familiarity of professional knowledge, cross grouping, increase the in-class computer experiment and practical operation drill hours. If the students have questions about the content of the lecture, the teacher can help them directly analyze and explain with test equipment. At the same time, teachers can timely grasp the learning effect of students through pre-class tests, questions in class and defense after class. For students who can't keep up with the progress, on the one hand, teachers can answer questions after class, and then move on to the next project. On the other hand, students can help each other by tutoring each other in their spare time to ensure that no student is left behind. After the completion of each task, it will be evaluated and fed back to the students in time through the quantitative methods

of teacher assessment and student mutual evaluation.

3.4. Aiming at the Demand of Talent Training, Improving the Ability of Teachers

In the traditional teaching process, teachers usually teach relevant chapters one by one according to the textbook chapters, and students learn passively [6]. Even if the teacher's teaching ideas are very clear, the students' learning effect is still unsatisfactory because the course knowledge points are too much and highly abstract and generalized. Under CDIO mode, teachers should do the following three aspects.

1) Deeply analyze the teaching objectives of the course and accurately analyze the needs of students for future positions. By visiting before the commencement of discussion, find out the theoretical foundation and practical ability of students, to clarify and grasp the students' weak link and needs, as far as possible in the whole teaching process in question for traction, open discussion of core knowledge, actively create the active atmosphere of the classroom teaching, improve the students' interest in learning.

2) Focusing on the working principle, operation and troubleshooting of the test equipment, the system structure, bus composition and other contents used by the existing test equipment are listed in detail, and the connection and difference between the working principles of the test equipment are clearly described, so that students can draw inferences from one example by grasping the working principles of the existing test equipment. In addition, teachers not only need to teach the use and operation of testing equipment through picture display, video demonstration and even computer operation, but also need to explain the common faults and troubleshooting methods of testing equipment, combine classroom theory teaching with engineering practice, analyze automatic testing equipment layer by layer, grasp the points of interest, guide students from passive learning to active learning, and strengthen the cultivation of students' post ability and professional quality.

3) Make full use of the opportunity to investigate the industrial departments and grassroots units, in-depth understanding of the process of development and production of test equipment in industrial departments. Be familiar with the design concept, design scheme and working principle of the test equipment, and collect the user manual, operation precautions, common faults and troubleshooting methods of the test equipment, so as to enrich the teaching examples, update the teaching content in time, and ensure that the teaching content is not expired. At the same time, understand the actual needs of grassroots units for talents, timely and appropriately adjust the teaching content and personnel training program.

3.5. Teaching Implementation of Combination of Theory and Practice Based on CDIO Mode

"Automatic test system" course teaching content mainly includes the basic knowledge of automatic test technology (such as the architecture of automatic

test system), measurement error, serial communication interface, parallel communication bus (GPIB bus), VXI bus, PXI bus and LXI bus technology, instrument driver development, software development and test the system integration technology and anti-jamming technology, etc., There are a lot of knowledge points involved and a wide range of knowledge. Therefore, teachers should combine the needs of talent training, grasp the main line of the curriculum, comprehensively comb the knowledge points, construct the knowledge scope, and integrate and optimize the teaching content into several teaching sub-projects with certain operability according to the teaching objectives and syllabus, even if the learning process becomes teaching sub-projects to consolidate students' theoretical knowledge, improve their practice ability [7] [8] [9].

In teaching target, more emphasis on "to be able to correct selection of instruments and can make actual operation", "to prepare the application testing software, master the methods of structure of automatic test system in the actual work and programming ability", based on this, for 40 hours of classes, we put the experiment period from eight hours to 14 hours. For 20 class hours, the experimental class hours will be increased from 4 to 6. And add the content of design experiment, as shown in Table 1. The content of the current experiment and the arrangement of class hours are shown in Table 2.

In the scheme conception stage, students will give full play to the group wisdom and individual innovative ideas according to the theoretical knowledge and experimental requirements, and draw up a functional scheme for the serial communication software to be designed and the verification experiment scheme. In

Table 1. Hours distribution of automatic test system teaching reform.

the total class hours are 40		the total class hours are 20	
original experimental hours	current experimental class hours	original experimental hours	current experimental class hours
8	14	4	6
verifiability 8 designability 0	verifiability 4 designability 10	verifiability 4 designability 0	verifiability 2 designability 4

Table 2. Content hours distribution of automatic test system teaching reform.

name of experiment	type of experiment	hours of experiment
experiment 1 GPIB instrument communication experiment	verification experiment	2
experiment 2 Compilation experiment of arbitrary waveform generator	design experiment	5
experiment 3 Serial port Communication experiment	verification experiment	2
experiment 4 establishment experiment of temperature test system	design experiment	5

the process of conception, students need to combine the theoretical knowledge of serial communication and RS-232C interface, and fully verify the mechanical characteristics, functional characteristics and connection characteristics of RS-232C interface. The teacher only discusses the feasibility of the scheme with students without restrictions on the basis of ensuring safety.

In the scheme design stage, students will design, write and test the scheme and function modules in detail based on the functional scheme obtained in the conception stage. At the same time, each team has to evaluate and analyze the division of labor and schedule of the project, and the engineering design ability and reasoning ability have been trained to a certain extent. The author fully communicates and discusses with students in the design stage, and gives guidance to the difficult problems encountered by students, but the final decision is made by students.

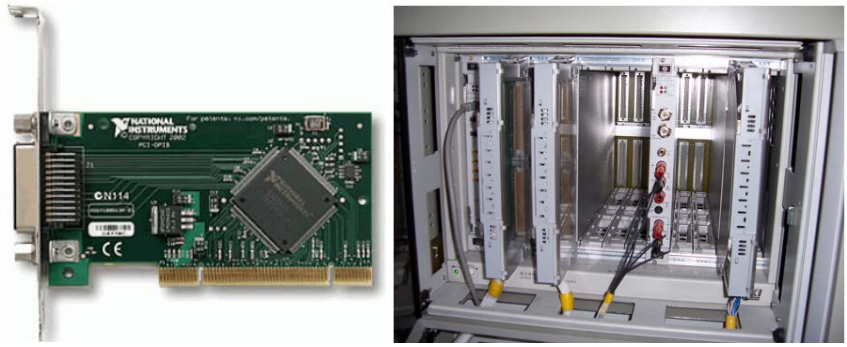
In the scheme implementation stage, each team completed the serial cable production, software programming and debugging, and experimental verification according to the scheme obtained in the design stage. Students search literature, communicate with other technicians, and develop their communication and collaboration skills.

In the running stage of the scheme, students will start to run the serial communication control software developed in the implementation stage, and complete the self-test of the serial communication module and the communication between serial ports. The operation of experimental scheme is an important stage to cultivate students' practical ability and teamwork ability. At the same time, students' understanding of theoretical knowledge is deepened through the use of self-made experiment.

3.6. Pay Attention to Laboratory Construction and Comprehensive Evaluation of the Integration of Theory and Practice

In order to enable more students to participate in the experiment, have access to the equipment, and better complete the design experiment independently, special emphasis is placed on one person and a group of experiments in the experimental teaching reform. Therefore, we vigorously promote the reform of experimental teaching, strive to improve the quality of experimental teaching, and increase the strength of laboratory construction. Therefore, the automatic testing technology laboratory purchased experimental equipment and developed a test system network teaching platform. **Figure 1** shows the GPIB bus interface card and VXI bus module.

Centering on the needs of talent training, teaching objectives and teaching contents, the traditional teaching mode is reformed with experimental reports and examination scores. Based on the evaluation mechanism, a comprehensive evaluation mechanism focusing on the integration of process, theory and practice has been established, which fully reflects the effect of project-based teaching under the CDIO mode. Pay attention to the process to carry out the course assessment and evaluation of the whole theoretical teaching and machine experiment



(a) (b)

Figure 1. GPIB bus interface card and VXI bus module. (a) NI PCI-GPIB Control interface card; (b) VXI bus module.

(practical operation training) process. In the process of theoretical teaching, students' learning effects can be mastered in time through pre-class tests, questions in class and defense after class. The examination of on-machine experiment (practical operation training) focuses on experiment preview, operation process, operation proficiency and safe operation consciousness. The integration of theory and practice not only evaluates theoretical knowledge, but also evaluates practical operation [10]. The theoretical examination mainly evaluates the core part of the curriculum knowledge system. The author improves the diversity and flexibility of the questions in the theoretical examination, and avoids placing too much emphasis on the mechanical memory of knowledge so that each question can reflect the deep understanding of the classroom knowledge, and relate to engineering practice whenever possible; the experimental operation is evaluated comprehensively according to the students' experimental report, the completion of the experimental project, and the project defense. This teaching method has been implemented in the automation major of grade 2019. The reform effect is good, and the practical ability of students has been greatly improved, which has been praised by students.

4. Conclusion

After years of exploration and practice based on CDIO engineering education mode, the "Automatic Test System" course gradually popular with students. It pays attention to the theoretical knowledge that students learn in the classroom and can be well applied to engineering practice. Employers also reflect that students' professional level and ability are gradually improved, which can well meet the requirements of existing posts.

Conflicts of Interest

The author declares no conflicts of interest.

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