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Reform of Electronic Technology Experiment Teaching Based on Engineering Education Professional Certification

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Abstract—The core idea of engineering education professional accreditation is to cultivate students' engineering consciousness and improve their engineering practice ability and engineering quality. Combined with the engineering education accreditation requirements and the outstanding problems in the process of teaching analyzed and summarized, the electronic technology experimental teaching system, teaching model, teaching contents, teaching methods, teaching evaluation and teachers' construction were reformed and explored. New ideas for the construction of the electronic technique experiment courses oriented engineering education professional certification are proposed, which are expected to motivate the students' autonomy, initiative and creativity full play and to further improve the experiment teaching quality. The research could provide methods for cultivating high-quality engineering and technical talents.

Keywords—electronic technology experiment, engineering practice ability, innovation ability, professional certification

I. INTRODUCTION

The core concept of the engineering education certification is student-centered, output-oriented, and through continuous improvement to improve the quality of student development. In order to comply with a series of new requirements for engineering education professional certification for engineering professional experimental teaching, college professional education should pay more attention to the cultivation of students' engineering practice ability and comprehensive innovation ability [1]. However, due to lack of engineering education experience, communication between schools and enterprises, and forward-looking understanding of market demand, engineering education is still generally in the stage of imparting knowledge transfer and ignoring the students' experience in the whole process of engineering practice. Because of that, students' interest in engineering learning is not high, and their engineering awareness and engineering practice experience are too few to meet the needs of society for high-quality engineering and technical talents [2]. Based on the analysis of the current teaching situation of electronic technology practice, combined with the requirements of engineering education certification standards for practical teaching [3], this paper proposes a program of teaching reform of electronic technology experiment course to improve the quality of engineering education, aiming to use the systematic, comprehensive engineering training to enable students to have the ability to solve practical engineering problems in a reasonable, economical and simple way, as well as teamwork, technical communication and independent innovation, to promote students to become high-quality engineering and technical personnel.

II. ANALYSIS OF STATUS QUO

A. Teaching Content Lack of Engineering

First of all, the experimental teaching content is single, lacking the cross-combination of multiple related courses, emphasizing too much verification and imitation, while ignoring design and innovation. Experimental teaching plays a very small role in the development of the students' personality and comprehensive ability, and can not meet the requirements of professional certification standards for practical teaching [4]. Secondly, the experimental project has a single technology and outdated content. It lacks the combination of engineering practice and technological frontier. It is difficult to cultivate students' independent thinking ability and the interest to actively explore new knowledge. The students' engineering practice ability can not be comprehensively cultivated and improved [5].

B. Teaching Model is Single

At present, the modes of experimental teaching of electronic technology are basically the same. First, the teacher specifies the experimental topic and prepares the experimental bench or the experimental box in advance. The circuit inside the experimental bench or the experimental box is connected, leaving only the wiring hole on the panel. When doing experiments, students only need to complete the wiring between the wiring holes. The experimental textbooks are mostly experimental guides that have been used for many years and all the operational steps have been thoroughly provided. After the teacher simply explains the experimental principles, the students can successfully complete the experiment by referring to the steps in the experimental guide. Students do not have a complete process experience. They only use the data to connect to the data and seldom think deeply about the inner principles. They lack discussion, communication and confliction with thinking, and they are not able to establish engineering awareness. It is also extremely unfavorable for students to form divergent thinking and creative ability.

C. Experimental Platform is Lagging Behind

The construction of school software and hardware lags behind, the experimental equipment is aging, the quantity is

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insufficient, and sometimes it is necessary for many students to share one piece of equipment. Some students can only watch or record, and they do not realize the sense of accomplishment; at present, most of the configuration of the laboratory is also a ready-made modular experiment board with components and circuits fixed, and the experimental content cannot be flexibly changed; in addition, the development software used in the experiment is also relatively simple, and the upgrade and transformation of the experimental platform is also more difficult. The high-level innovative experimental platform is lacking, and the resource informationization degree of the curriculum is low.

D. Teaching Resources Development is Insufficient

At present, the engineering education of most colleges and universities is obviously out of touch with the industrial world. The engineering education that should be open to the public has almost become a closed school education, and rich social resources are difficult to use. In addition, the development and utilization of engineering practice courses in the school is not enough, and the engineering practice education's advantages and functions of concrete problems, visualization, simplification and fun aren't realized appropriately. The lack of sufficient understanding of theoretical issues such as knowing the diversity of engineering practice teaching forms and the law and the core functions of engineering training has led to the relative lack of engineering practice resources and the wasteful of valuable resources[6].

E. Imperfect Evaluation

The traditional assessment is mainly for theoretical knowledge. Most of the experiments are not regarded as a separated course, and the assessment criteria are also low. The final scores are basically determined based on the attendance and experimental reports. The actual situation is that the content of the experimental reports of most students are basically copied from the experimental textbook, and the plagiarism phenomenon is widespread, which cannot reflect the real process and effect. Such experimental teaching evaluation leads to the experiment only in the form, which does not reach the expected effect of consolidating the theory and cultivating students' ability. In addition, the subject of the evaluation and evaluation of the experiment is single. Only the teacher evaluation is emphasized and the self-evaluation and mutual evaluation of the students have been neglected, which makes it impossible to conduct an accurate and comprehensive evaluation of the student's abilities.

III. Constructing A New Idea of Experimental Teaching

A. Strengthen the Exchange and Integration Among Courses

At present, most of the experimental teaching is attached to the theoretical teaching, and only to meet the teaching needs and rarely consider the connection with other courses. The items in the experimental content are mostly independent of each other, and lack of close contact with the subsequent curriculum design, professional comprehensive training, graduation design and other aspects [7], which is extremely unfavorable for cultivating students' engineering practice ability. To this end, the following suggestions are made: (1) The "Electronic Technology Experiment" should be set up separately, independent from the analog and digital electronic technology courses, and the experimental syllabus and teaching plan are separately formulated and evaluated separately. (2) In the selection of experimental content, we should pay attention to the combination of theory and practice, the combination of foundation and frontier, and the combination of knowledge and engineering. Reduce the verification experiment, and only keep the items used in common electronic measuring instruments to cultivate the basic experimental quality of students. For representative experiments such as common-emitter amplifying circuits, a more practical application working environment can be set up, making it a comprehensive or research-oriented experimental project closely related to practical applications, so as to improve students' experimental interest and broaden their horizons. According to the different professions, select some experimental items from the design of basic amplifier circuit, the design of power supply, the design of power amplifier circuit, the design of competition responder, digital electronic clock, multi-function signal generator, etc. The ability to analyze, design and produce electronic circuits lays the foundation for future participation in engineering projects. In addition, in order to enrich the teaching content, it can be integrated into some cutting-edge or other related disciplines, such as the appropriate introduction of EDA, FPGA, MCU, sensors, etc., which can provide basic guidance for students to fully understand the design needs and connotations of today's electronic products. It is conducive to comprehensively demonstrate the connections between related disciplines such as electronics, automation, and control technology, and fully stimulating students' sense of innovation. (3) Carry out cooperation in production, education and research. In this way, students will be provided with “real guns” projects and venues to consolidate students' theoretical knowledge and improve students' overall quality in teamwork, communication, management and service. In addition, through the communication between school and industrial engineering experts, innovative and improve experimental teaching ideas and programs to make students' practical ability and industrial engineering needs more closely match.

B. Organization of Teaching Concepts

According to the concept of engineering education professional certification, the experimental teaching method should be changed from the traditional "principle verification" to "engineering ability training". It is suggested to establish an organizational teaching concept of CDIO (concept-design-implement-operate) for experimental teaching [8]. For the conception and design, before the experiment, the teacher should not provide the students with a complete experimental design plan. Instead, they should first ask the students to preview, examine the existing instruments and equipment in the laboratory, find reference materials through the Internet, libraries, etc., and then complete the design independently. Experiment with the program and do the reporting and discussion. For the implementation and operation, during the experiment, students are allowed to experiment according to their own designed schemes, minimize the use of modular experimental boards, and let students build their own circuits. For the problems and errors that occur during the experiment, the teacher should not immediately correct it, but consciously cultivate students' ability to discover problems, find reasons, solve problems, etc., in order to help students adapt to

engineering innovation practice in the future. After the experiment, students are required to analyze and summarize the experimental process, technical methods, and experimental results. For the more difficult comprehensive experimental project, it can be carried out by organizing a group-based collaborative teaching mode. The teaching class is divided into 2-3 person-based learning groups, and the team members determine the experimental plan of the group through discussion. In the experimental class, the teams sent representatives to introduce the design plan and ideas. The groups can exchange ideas and finalize the design. Group competitions can also be conducted between groups, which are assessed and ranked by experimental teachers. Students benefit greatly from the exchanges and cooperation between the groups.

C. Reform Experimental Teaching Mode

The project pedagogy has unique advantages in cultivating students' engineering practice abilities. Moderately select typical and practical comprehensive experimental projects, and use the guiding role of the project to guide students to develop the habit of independent thinking, independent research, active exploration, and stimulate students' creative potential [9]. The implementation of the project teaching method is that the teacher gives the specific experimental teaching tasks to the students in the project situation. The students regard the experimental project as “engineering” for conception, design, implementation and operation, and combine the experimental process with the actual production of the enterprise. Identify the responsibilities and tasks of each member in an enterprise management model. The specific operation is roughly the following three steps: (1) Specify the target task. According to the students' knowledge level and practical ability, the students are assigned target tasks. The students form the teams, three people per team. The team members discuss with each other and inspire each other to determine the design plan. Each task preferably has a certain practical application background, and there are as many design options as possible. (2) Program design. According to the existing experimental conditions screen programs, set the tasks, complete the circuit schematic design, simulation and verification, to ensure that everyone can participate in the design and production of the project according to different division of labor. (3) Hardware implementation and operation. The designed circuit is first simulated to ensure that the circuit is built and debugged without any errors. Through the components selection, circuit welding installation, circuit measurement debugging, experimental report writing and other aspects to complete the entire project.

The project teaching method can enable students to experience a complete and systematic training process from data review, program demonstration, simulation test, circuit production to problem finding and problem solving, which is conducive to cultivating students' "school is company" normative awareness, "student is employee" responsible awareness, the professional consciousness of “working in class” and the quality consciousness of “work is product” [10]. Project implementation can not only improve students' engineering awareness, engineering quality and engineering practice ability, but also improve their professional competitiveness and social adaptability.

D. Updating Experimental Teaching Content

Electronic technology involves knowledge of information, electronics, machinery, materials, management, etc. It is rapidly moving toward miniaturization, intelligence, green, integration, and high precision. Teachers should be good at discovering and appropriately introducing these advanced knowledge and techniques to broaden their horizons. For example, the working principle of electronic devices such as "field effect transistors" and "integrated operational amplifiers" in analog circuits are more abstract, difficult to understand, and diverse, which are easily confused. In addition to comparing their structure and working principle with semiconductor triodes, teachers can also introduce their important position in modern electronic products and integrated circuits, so that students can access these new devices and learn about new technologies. Updating of experiment contents will stimulate students' interest and improve their engineering awareness.

In the teaching mode, teachers can use the modern educational technology and virtual simulation technology to improve the efficiency of experimental teaching and improve the experimental teaching effect according to the teaching content and the characteristics of the teaching object [11]. Flexible teaching methods such as multimedia courseware explanation, difficult animation demonstration, circuit puzzle game and various virtual simulation tests can increase the interest of teaching and make up for the lack of traditional teaching. You can also create online courses with the help of a web platform to achieve vivid and interactive teaching effects. Students can see vivid virtual electronic components, experimental principles, and animated demonstrations of experimental procedures, making abstract and difficult problems easy and specific, which is unmatched by traditional teaching models [12]. In order to pay close attention to the students' dynamics, the teachers can also establish class groups, and communicate with each other in a timely manner, which not only improves the students' autonomy, but also improves the students' enthusiasm for learning. The introduction of new educational technology can not only enrich teaching methods, but also help students actively construct knowledge, acquire knowledge and self-renew knowledge.

E. Establish Diversified Experimental Assessment Method

The experimental assessment has a direct guiding effect on student learning, which not only can promote the realization of teaching objectives, but also stimulate students' interest in learning. Traditional experimental assessments frequently tend to light process, and lack of strict quantitative standards, which will inevitably lead to unfair assessment of performance. At the same time, the evaluation of students' teamwork ability, independent learning ability, electronic circuit design and development ability and innovation ability are also neglected. The diversified formative evaluation method is the evaluation of students' "knowledge", "ability" and "quality" in the whole experiment process, around the design of experimental programs, the process of experimental operations, the analysis and summary of experimental results, the attitude of experimentation, the ability of solidarity and cooperation, and the quality of innovation. Diversified formative assessment combines students' performance in the four stages of conception, design, implementation and operation to comprehensively

assess the whole process of students' completion of experiments, focusing on non-intellectual factors including learning attitudes, state, effects, strategies, etc. The objective evaluation of factors can also promote students' active participation and reflection on the experimental process, and also promote teachers' improvement and innovation of experimental teaching methods. Taking the design of the digital electronic clock as an example, in the early stage of the assessment, the students complete the collection of relevant data and the learning of the unit module circuit in accordance with the functional requirements of the digital electronic clock circuit; after that, the design and simulation of the schematic diagram of the electronic clock circuit, the design and manufacture of the PCB board, the design, welding and debugging of the circuit board are completed. Finally, the writing of the design report, the preparation of the PPT and the summary of the whole experimental process are carried out. During the assessment, it pays attention to the assessment experiment process, focusing on assessing students' ability to use instruments and meters, fault analysis and elimination capabilities, and processing and analysis capabilities of experimental data. The performance report and response data accounted for 40% of the total scores, and the intermediate process such as pre-study, instrumentation, and experimental operation during the class accounted for 60%. This kind of assessment method focuses on the comprehensive evaluation of students' knowledge, ability and quality, and objectively evaluates the students' experimental level.

IV. Conclusions

Based on the concept of the engineering education, transforming educational thoughts, reforming teaching methods, grasping experimental teaching as a key link to achieve talent training objectives, and infiltrating engineering awareness and engineering ability into the experimental teaching process, it is important for improving the quality of engineering education. The reform of electronic technology experiment teaching for engineering education professional certification reflects the development requirements of contemporary engineering education, conforms to the development trend of engineering education, and plays an important role for teachers and students.

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