Advances in Social Science, Education and Humanities Research, volume 286

3rd International Seminar on Education Innovation and Economic Management (SEIEM 2018)

Reform and Practice of Automation Professional Training Based on School-enterprise Cooperation

—Taking the College of Applied Technology of Dalian Ocean University as an Example

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***Abstract*—In order to improve students' vocational post skills, this paper takes the automation major of Dalian Ocean University as an example to reform the training teaching. First, school-enterprise cooperation determines the direction of professional posts and training objectives, and implements the "double certificate" and "multi-certificate" system. Second, school-enterprise cooperation reforms the practical training teaching system and means, including: increasing the proportion of practical training teaching; improving the comprehensive quality of practical training teachers; strengthening the construction of teaching hardware; strengthening the construction of off-campus practice bases; carrying out innovative entrepreneurship education; implementing the objective of practical training teaching in stages, etc. Thirdly, we should reform the assessment methods of practical training and pay attention to the process assessment. Through the reform practice, good results have been achieved, which is worth learning and promoting.**

Keywords—school-enterprise cooperation, automation specialty, practical training, teaching reform, ability

I. INTRODUCTION

The practice of the basic course and the specialized course of automation specialty is very strong. Many abilities and knowledge can only be truly cultivated and mastered by means of practical training. Therefore, the practical training teaching link is very important in the teaching of this specialty. To deepen the teaching reform, we must pay special attention to the reform of the practical training teaching link. The training goal of automation specialty is to cultivate all-round development of morality, intelligence, physique and beauty[1], possess the necessary basic knowledge of automation specialty, master the basic knowledge and skills of electrical control, computer control and automatic control, possess the basic abilities and professional qualities of electrical engineers, and be able to work in the fields of automation and electrical engineering in enterprises and institutions[2]. Since 2014, the College of Applied Technology of Dalian Ocean University has made great reforms and practices in the practical teaching of automation specialty, and achieved good results.

[Fund Project] Liaoning Provincial Vocational and Technical Education Association Research Planning Project: Innovative Research and Practice of School-enterprise Cooperation in Training Applied Talents (LZY17560); Liaoning Province Education Science "13th Five-Year Plan" 2018 Project: Application of Undergraduate Automation Professional Practice Skills Cultivation Innovation Research (JG18EB033).

II. SCHOOL-ENTERPRISE COOPERATION TO DETERMINE THE DIRECTION OF PROFESSIONAL POSTS AND TRAINING OBJECTIVES

A. Convene A Professional Seminar Based on Enterprise Experts to Determine the Direction of the Automation Profession

Two seminars on automation were held in 2016 and 2017. Through the seminars, the orientation of the posts of automation specialty was determined as follows: electrical design and maintenance, operation and maintenance of automation equipment and power supply and maintenance.

Enterprise experts also suggest timely reflection of professional new technologies, new products, new processes and new materials. Therefore, the major of automation has added courses such as *Industrial Robot Technology* and *Inverter Technology*, and set up corresponding curriculum design. The training part of *Inverter Technology* is arranged in the course design of electrical practice and PLC application technology.

B. Aim at cultivating application ability, innovation ability and professional post ability

The reform of practical training teaching of automation specialty aims at cultivating students' practical application ability, innovation ability and vocational post ability. The automation professional training reform is aimed at cultivating students' practical application ability, innovation ability and professional position ability, allowing students to clarify the specific tasks and objectives of training, and to carry out training with purpose, to stimulate students' desire for knowledge, and have an interest in the training content. For example, the training goal of motor assembly practice is to be able to repair the motor. Students practice motor fault detection, winding, inserting and wiring. They can also take the initiative to repair various motors for schools and classmates, and unconsciously improve their professional post application ability.

C. Promote "Double Certificate" and "Multi-certificate" System

Vocational qualification certificate (such as electrician's certificate) can more accurately reflect students' vocational post ability and level. Students majoring in automation in College

of Applied Technology of Dalian Ocean University should obtain at least one vocational qualification certificate during their second class. That is to say, the graduates of automation specialty of Dalian Ocean University College of Applied Technology have obtained "double certificates", and some have also obtained "multi-certificates", which are welcomed by employers. The types of vocational skill certificates for automation majors are shown in Table 1

TABLE I. VOCATIONAL QUALIFICATION CERTIFICATE FORM

Serial number	Certificate name	Grade
1	Electrician certificate	Intermediate or advanced
2	Electronic fitting certificate	Intermediate
3	Radio debugger certificate	Intermediate
4	Foreign language certificate	Level four or six
5	Computer certificate	Level 1 or two
6	Computer graphician certificate	Qualified
7	NC machining and programming certificate	Qualified

III. REFORM OF PRACTICAL TRAINING TEACHING SYSTEM AND MEANS THROUGH SCHOOL-ENTERPRISE COOPERATION

A. *Increase the Proportion of Practice Teaching*

The core courses of automation major are Circuit Foundation (24 hours of experiment), analog electronic technology (24 hours of experiment), digital electronic technology (24 hours of experiment), motor and drag (24 hours of experiment), single-chip computer application technology (all on-line experiments), power electronics technology (16 hours of experiment), computer control technology (on-line), electrical control technology (24 hours of experiment), PLC application technology (all on-line experiments), etc. All of them are taught in the integrated classroom of teaching, learning and doing, adopting project teaching method, task-driven, and integrating theory with practice. The proportion of practical teaching and theoretical teaching of Automation Specialty in Dalian Ocean University College of Applied Technology is 1.52:1.

In order to improve students' vocational skills, centralized training links are arranged in the personnel training program, as shown in Table 2.

TABLE II. CENTRALIZED TRAINING LINKS OF AUTOMATION SPECIALTY

Serial number	Training project	Credit	Number of weeks
1	Military training	2	2
2	Innovation and entrepreneurship practice	2	2
3	Metalworking internship	1.0	1
4	Electrician internship	2.0	2
5	Electronic equipment installation and commissioning	2.0	2
6	Digital electronic technology course design	1.0	1
7	Motor process assembly internship	2.0	2
8	MCU application technology course design	1.0	1
9	Power electronics technology course design	1.0	1
10	Computer control technology course design	1.0	1
11	Industrial robotics course design	1.0	1
12	Electrical internship	2.0	2
13	PLC application technology course design	1.0	1
14	Process control system and automation instrumentation course design	1.0	1
15	Electrical CAD training	2.0	2
16	Professional literacy and comprehensive skills training	8.0	8
17	Internships	14.0	14
18	Graduation design (thesis)	12.0	12

B. *Improve the overall Quality of Practical Teachers*

Break the boundaries between theoretical teachers and practical teachers. Teachers take turns in enterprise training (more than half a year). It can broaden the scope of knowledge, enhance the application ability of comprehensive knowledge, train a group of teachers with strong practical ability and rich experience to undertake practical training tasks, and improve the level of practical teaching. There are 16 full-time teachers in automation specialty of Dalian Ocean University College of Applied Technology, 4 full-time teachers who have worked in enterprises for more than 2 years, 4 full-time teachers who have worked in enterprises for more than half a year, and 8 full-time teachers who have certificates of engineers and builders. Others also participated in the "double teacher training." There are 2 doctors and 12 masters. The high-quality "double-skilled" faculty team effectively guarantees the effectiveness of the training.

C. *Strengthen the Construction of Training Hardware in the School*

In order to train high-quality professional and technical application-oriented talents and enrich some experimental and training equipment related to the current frontier of scientific and technological development, the following laboratories have been constructed for the automation specialty according to the requirements of the practical training teaching system and content: (1) Electrical basic teaching as an integrated room; (2) Electronic technology teaching as an integrated room; (3) Electrical motor and drive teaching as an integrated room; (4) Power electronics teaching as an integrated room; (5) Electrical control teaching as an integrated room; (6) MCU teaching as an integrated room; (7) PLC teaching as an integrated room; (8) Inverter teaching as an integrated room; (9) Mobile communication teaching as an integrated room; (10) Industrial Robot Training Room; (11) Electrical and Electronic Training

Room; (12) Electrical Control Training Room; (13) Integrated Training Room; (14) Innovation and entrepreneurship training incubation function room (2); (15) Metalworking Practice Factory, (16) Electrical Practice Factory, (17) NC Machining Center and other in-school training bases. By using these advanced experimental devices and training equipment to provide demonstration, verification, comprehensive, design experiments and training, students can broaden their horizons and cultivate students' interest and innovation.

D. Strengthen the Construction of Off-campus Training Base

(1) Take various measures to contact enterprises and institutions as much as possible as possible as possible as possible as an off-campus training base. At present, there are two provincial practical education bases for automation specialty in the College of Applied Technology of Dalian Ocean University; Wafangdian Bearing Group Co., Ltd., Wafangdian Electric Power Co., Ltd., Dalian Machine Tool Factory, Wafangdian Metallurgical Bearing Group and Zhongcao Group and 12 stable substantive off-campus training bases (school-enterprise cooperation units) have been established. Engineers with rich practical experience in enterprises are employed as visiting professors to guide students' practice and participate in the formulation of personnel training programs.

(2) Arrange training instructors to go to enterprises (off-campus training bases) for social practice training first. Through on-the-spot investigation of enterprises and combined with the training objectives of automation specialty, formulate training outlines, and work out practice plans with guest professors of enterprises according to the requirements of training content, and enable students take questions to practice and the purpose to practice. In addition, Dalian Ocean University College of Applied Technology Automation specialty also has two incubation function rooms for innovation and entrepreneurship training. Now teachers and students to the enterprise to solve technical problems have been increasing year by year through participating in the construction of two alliances.

E. Carry out Innovation and Entrepreneurship Education

In order to cultivate high-quality and top-notch talents with innovative spirit and practical ability, a series of innovative entrepreneurship courses are offered in automation major of Dalian Ocean University, including four modules: basic courses, public elective courses, specialized courses and practical links. Students are required to study at least 7.5 credits. According to their abilities and interests, students can complete various small scientific and technological production by drawing up their own topics and directions, and use their spare time to complete. Since 2015, more than 20 provincial, school and college-level innovative entrepreneurship projects such as "Intelligent lawn mower" and "Intelligent wardrobe" have been sponsored by students majoring in automation. The participation rate of students is over 80%. The "Intelligent lawn mower" has won the first prize in Liaoning Innovation Competition. "Dream Host Team" won the Silver Award of "Creating Youth" Liaoning Entrepreneurship Competition.

F. Implement the Teaching Objectives of Practical Training in Phases

The internship of automation specialty has three stages. The first stage is the primary goal. Students will participate in the metalworking internship for 1 week to master the basic knowledge of mechanical engineering required for engineering technology and participate in electrician internship for 2 weeks to master the wiring and installation of lighting circuits, wiring and control principles of simple electrical control circuits. The second stage is the intermediate goal. Students will practice for 2 weeks in the installation and debugging of electronic equipment, master the installation, welding technology and debugging technology of electronic equipment, practice in motor assembly for 2 weeks to master the insertion and installation technology of motor and in electrical control for 2 weeks to master the principle of electrical control circuit, wiring and troubleshooting. The third stage is the high-level goal. Vocational accomplishment and comprehensive skills training will last for 8 weeks, specially strengthening training for three positions of electrical design and maintenance, operation and maintenance of automation equipment and power supply maintenance of automation specialty. The internship will last for 14 weeks. The internship will be carried out in real positions in the form of real entry, which will lay a good foundation for future work. Through three stages of practical training, we can fully cultivate students' vocational post ability, as well as the ability to analyze and solve problems.

IV. Reform the Examination Method of Practice Training

In order to improve vocational post skills, automation professional training assessment should be comprehensive, fair and reasonable, and process assessment should be emphasized.

Motor and Drive Experiment and other experimental contents were assessed separately: attendance and performance accounted for 20%, experiment operation accounted for 40%, experiment report accounted for 20% and experiment written test accounted for 20%; Examination of curriculum design, such as "Course Design of Single Chip Microcomputer Applied Technology": attendance and performance in peacetime accounted for 20%, design works accounted for 50% and design specifications (reports) accounted for 30%. Practice assessment, take "Electrical Machinery Process Assembly Practice" as an example: practice attendance and performance accounted for 20%, practice works accounted for 50%, lottery oral test accounted for 10%, practice records accounted for 10% and practice reports accounted for 10%.

In this way, the practical training assessment is more reasonable, fully mobilizing the enthusiasm of students, students also pay more attention to peacetime, pay more attention to practical operation, so that students' practical ability, innovative ability, vocational post ability has been significantly improved.

V. Effect and Innovation

Through the practice of training teaching reform of automation specialty, initial results have been achieved. In the past three years, automation majors have participated in more

than 20 innovative entrepreneurship training projects, and won 22 awards at or above the provincial level in skill contests; four utility model patents and three computer software copyrights were obtained, and four papers were published by students. The employer's overall satisfaction with automation graduates is more than 95%. The employment rate of automation graduates reached 99% in 2018.

The main innovations in the practice of practical training teaching reform are that school and enterprise cooperate collaboratively, the construction of the training course system is determined by holding a professional seminar attended by experts from the enterprise (industry); the "backward inference" method is adopted, that is, along the line of enterprise (industry) investigation - job orientation analysis - vocational ability analysis - drafting of practical training curriculum system - joint demonstration between school and enterprise; school-enterprise cooperation runs through training and teaching; the ratio of practical teaching to theoretical teaching is 1.52:1; innovation and entrepreneurship education is carried out, and the innovation and entrepreneurship training incubator function room is built.

VI. Conclusion

In short, through the reform of practical training teaching in recent years, students' comprehensive quality, innovative ability and vocational post ability have been generally enhanced. With the development of social science and technology, on the basis of existing achievements, the practical teaching reform of automation specialty should be further deepened and perfected, and gradually make it more scientific and reasonable.

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