Exploration and Practice of '1+X' Certificate in Industrial Robot Application Programming

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Abstract: As the 2nd batch of X certificate pilot, how to design the certificate integration plan and improve the quality of personnel practical training is a problem worthy of exploration. According to the basic ideas of standard integration, curriculum integration, practical practical training system integration and assessment and evaluation system integration, Yangling Vocational &Technical College adopts five kinds of integration methods, including increasing course, increasing practical training, increasing content, strengthening before examination and replacing examination with certificate, to carry out the integration of curriculum and certificate, and promote the reform of teachers, teaching methods and teaching materials, and the construction of management system.

1. Introduction

The *National Vocational Education Reform Implementation Plan* clearly states that, from 2019, vocational colleges and applied undergraduate colleges and universities have launched the pilot program of the “Education Certificate + Certain Vocational Skill Level Certificates” system (hereinafter referred to as the 1+X certificate system pilot) [1]. According to the requirements of the pilot program, the vocational skill level certificate is divided into elementary, intermediate, and advanced levels, which can reflect the comprehensive ability required for professional activities and personal career development, and is a certificate of the professional skill level of qualified workers. The 1+X certificate system is a new system design that comprehensively improves the level of vocational education under the background of implementing “delegation, management and service” [2]. The pilot program encourages students from vocational colleges to actively obtain multiple types of vocational skill level certificates “X” while obtaining academic certificate “1” to expand their skills in employment and entrepreneurship. As the second batch of X pilot certificates, the “Industrial Robot Application Programming” vocational skill level certificate has been fully implemented in China since 2020. however, it is necessary to deeply explore the topics including selecting majors to be participated in X pilot certificates, the integration of talent practical training scheme and professional teaching standard and vocational skill levels and standards, through the promotion of “curriculum-certificate integration”, innovating talent practical training and practical training models, and improving the quality of talent practical training.

2. Basic idea of “Industrial Robot Application Programming” 1+X “curriculum-certificate integration”

The 1+X pilot requires the integration of major setup with industry needs, curriculum content with professional standards, teaching and production processes. It is necessary to solve the long-standing problems of “teaching separated from reality and major separated from profession” [3]. The 1 in "1+X" is the academic certificate, which is the foundation; the X certificate is supplement, enhancement and expansion [4]. In the course of curriculum-certificate integration, the path of curriculum-certificate integration is designed according to the basic ideas of standard integration, curriculum integration, practical training system integration, and assessment system integration, as shown in Fig.1.

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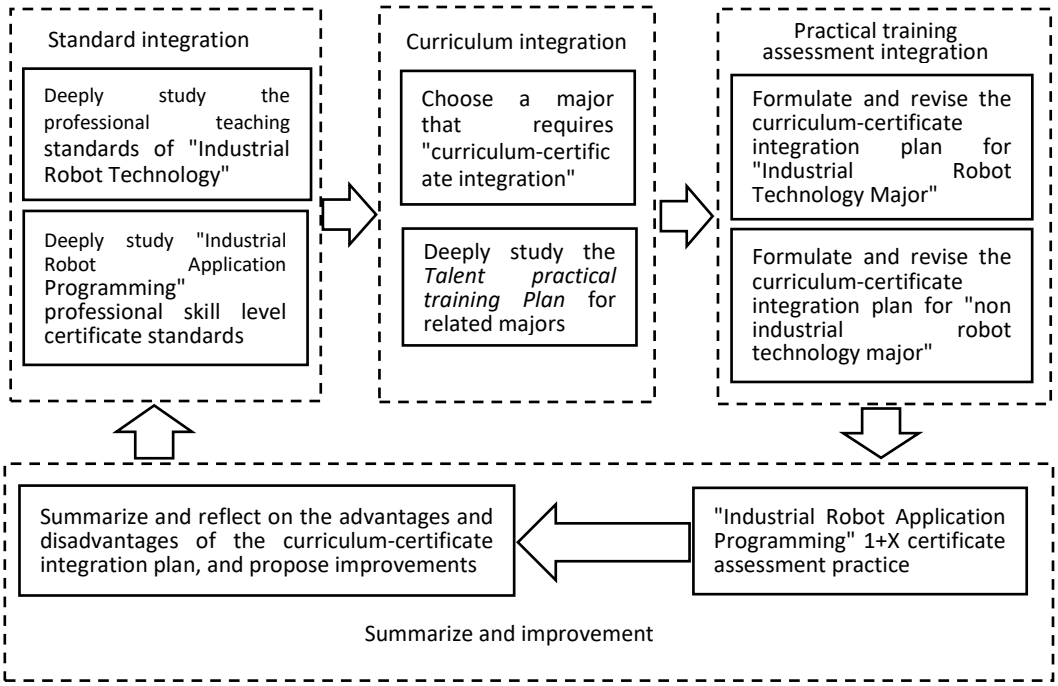

Fig.1 Industrial Robot Application Programming 1+X of the curriculum-certificate integration plan

First, by studying the *Industrial Robot Technology Professional Teaching Standards* (hereinafter referred to as *Teaching Standards*) and *Industrial Robot Application Programming Professional Skills Level Certificate Standards* (hereinafter referred to as *Level Standards*), clarify the relationship between the two and complete the standard integration; Secondly, for the industrial robotics major, the X certificate is a supplement and enhancement to the academic certificate, and for non industrial robot technology majors, the X certificate is an extension [5]. Considering that the wide industry application of industrial robots, from the perspective of broadening employment channels and increasing the competitiveness of students in workplaces, it is proposed to integrate industrial robot technology major, electrical automation technology major, mechatronics, mechanical design and manufacturing, as well as mechanical and electrical equipment maintenance and management in the "Industrial Robot Application Programming" 1+X Vocational Skill Level Certificate curriculum-certificate integration, formulate two sets of curriculum-certificate integration plans, and modify curriculum setting in conjunction with the talent practical training plan of related majors to complete the curriculum integration; Thirdly, formulate practical training system integration and evaluation system integration; finally, pass the 1+X certificate assessment practice, summarize and reflect on the advantages and disadvantages of the "curriculum-certificate integration" program, and put forward suggestions for improvement, so as to continue to modify and improve the course certificate accommodation program.

3. Measures for 1+X curriculum-certificate integration

3.1 Standard integration

Professional teaching standards, the basic basis for formulating talent practical training programs, stipulate the goals and requirements of talent practical training, and make specific regulations for position goals, knowledge goals, and ability goals. According to the *Teaching Standards* promulgated by the Ministry of Education in 2018 and the requirements of the professional teaching standards for industrial robotics, the courses offered are divided into 3 parts: professional basic courses (6-8 courses), professional core courses (6-8 courses), and professional development courses (6-11 courses). Professional core courses include programmable controller technology, industrial robot application system modeling, industrial robot system offline programming and simulation, industrial robot field programming, robot vision technology and application, industrial robot application system integration, industrial robot application system debugging and operation,

and industrial robot system maintenance. The core courses mainly cultivate vocational ability, and emphasize the practicality and professionalism of the courses.

In 2019, the "Industrial Robot Application Programming 1+X Certificate", as the 2nd batch of 1+X certificate pilots in China, was organized, managed, developed and implemented by Beijing Science&Education Development Co., Ltd. for grade standards. The industrial robot application programming vocational skill level certificate is divided into elementary, intermediate, and advanced levels, corresponding to secondary vocational, higher vocational, and application-oriented undergraduates. At the higher vocational colleges, it is mainly oriented to industrial robot technology, mechatronics technology, electrical automation technology, machinery manufacturing and automation. According to the requirements in the *Level Standard* (Intermediate), personnel with intermediate skills should comply with safety regulations and set parameters for industrial robot units; connect and control industrial robots and common peripheral equipment; compile industrial robots cell application program according to actual needs; build a corresponding simulation environment according to actual workstations, perform offline programming of typical industrial robot cells, and engage in industrial robot system operation programming, automation system design, industrial robot cell offline programming and simulation, and industrial robots unit operation and maintenance, industrial robot testing in related jobs.

From the above analysis, it can be seen that the *Teaching Standards* and the *Level Standards* have the same goals for job objectives and knowledge and competence, but there are still certain differences between the two. The first one, as the standard of academic certificate "1", reflects the requirements for basic professional technical skills; the second one is not a simple repetition of *Teaching Standard*, reflecting the industry-oriented job requirements, which is a requirement for mastering new technologies and new skills, and a supplement, enhancement and expansion of the *Teaching Standards*.

3.2 Curriculum integration

3.2.1 Integration for industrial robot technology major

Through the comparative study and analysis of *Teaching Standards* and *Level Standards*, Table 1 can be obtained. In Table 1, the *Level Standard* (Intermediate) is divided into 3 work areas, 11 work tasks, and 31 skill assessment points. For industrial robotics technology major, these skill assessment points can be found in the *Major Standards* and *Talent practical training Program* to find the corresponding professional core courses. Teachers can adopt the “embedded” method for skills assessment points while teaching. According to the requirements of skills assessment, targeted "increasing content" or "increasing practical training" or "no need to change" can subtly complete in the daily teaching of the course the theoretical explanations and practical exercises of the assessment points, and the "curriculum-certificate integration" for the industrial robot technology major without adding additional learning burdens to students.

3.2.2 Integration for non industrial robot technology majors

For students in non industrial robot technology majors such as mechatronics technology, electrical automation technology, mechanical manufacturing and automation, mechanical and electrical equipment maintenance and management, because their professional courses are very different from those of robotics, it is more difficult for students to complete the "curriculum-certificate integration" through the "increasing content" embedded method, and it is required to choose the "increasing course" method to realize "curriculum-certificate integration".

Taking into account the different professional foundations, the curriculum-certificate integration is divided into two versions, "industrial robot major" and non industrial robot technology majors, as shown in Table 2, implemented separately. In the curriculum-certificate integration, five methods are used, including "increasing course", "increasing practical training", "increasing content", "strengthening before examination", and "replacing examination with certificate". Among these, "increasing course" and "increasing content" belong to curriculum integration, "increasing practical training" and "strengthening before examination" belong to the practical training integration, and

"replacing examination with certificate" belongs to the integration of assessment and evaluation system.

Table 1 Curriculum integration

Industrial Robot Application Programming Occupation Skill Level Standard (Intermediate) Skill Test Point	Course corresponding to industrial robot technology professional teaching standard	Teaching content adjustment in industrial robot technology talent practical training program
Set industrial robot system parameters	"Industrial Robot Field Programming"	No need to change
Set up an industrial robot teaching box	"Industrial Robot Maintenance and Repair"	No need to change
Set the external device parameters of the industrial robot system	"Industrial Robot Application System Integration"	No need to change
Extended IO application programming	"Industrial Robot Field Programming"	increasing content
Advanced programming of industrial robots	"Industrial Robot Field Programming"	increasing content
Communication programming of industrial robot system and peripherals	"Programmable Controller Technology"	increasing content
Typical system application programming of industrial robots	"Industrial Robot Application System Debugging and Operation"	Increasing practical training
Construct simulation environment for industrial robot system	"Industrial Robot Application System Modeling"	No need to change
Industrial robot system model parameter configuration	"Industrial Robot System Offline Programming"	No need to change
Industrial robot system programming and simulation test	"Industrial Robot System Offline Programming"	increasing content
Industrial robot calibration and testing	"Industrial Robot System Maintenance"	increasing content

Table 2 curriculum integration plan

Curriculum integration plan	Increasing course	Increasing content	Increasing practical training	Strengthening before examination	Replacing examination with certificate
Industrial robot technology major	No need to increase	Increase content to 5 courses including "Industrial Robot Field Programming"	Add 30 credit hours of "Industrial Robot Application Programming Pre-job Comprehensive practical training"	10 credit hours of intensive practical training	Exempt from "Industrial Robot Maintenance and Repair" course
Non industrial robot technology majors	Add 50 credit hours of "Industrial Robot Application Programmin g" course	No need to increase	No need to increase	30 credit hours of intensive practical training	Exempt from "Industrial Robot Application Programming" course

Increasing course: considering that the professional courses taken by students of non industrial robot technology majors do not involve the basic knowledge of industrial robots, so the pressure of examination and study is heavy. In order to meet the X-certificate assessment requirements and reduce the learning pressure of students, new courses must be opened to make up for the "short board" of industrial robot technology. Therefore, for the 4 non industrial robot technology majors, a 40-hour professional elective course "Industrial Robot Application Programming" will be added.

This course is based on the assessment standards of the "Industrial Robot Application Programming" vocational skill level certificate, formulates corresponding course standards, and uses self-edited school-based textbooks to carry out teaching.

Increasing content: For the industrial robot technology major, professional course teaching has been fully integrated with the skill certificate assessment standards. In order to meet the skill assessment requirements, "Industrial Robot Field Programming" needs to add "Communication with PLC through group signals" and "Use multitasking to write robot programs." "Programmable Controller Technology" needs to increase the "preparation of RFID application program" and "industrial robot combined with machine vision intelligent sensor detection technology application program". "Industrial Robot Application System Debugging and Operation" course needs to add 30 credit hours of "industrial robot application programming pre-job comprehensive practical training". "Industrial Robot System Offline Programming" needs to add "typical application of industrial robot system offline programming and application debugging". "Industrial Robot System Maintenance" needs to increase "industrial robot performance parameter test" and "writing test analysis report".

3.3 Practical training system integration

The integration of the practical training system requires the connection and cooperation of site, content, schedule, lab and teachers of the course practical training in the academic certificate and the X certificate assessment practical training. It can be implemented through “increasing practical training” and "strengthening before examination".

Increasing practical training: For the major of industrial robot technology, it needs to increase 30 credit hours of “pre-job comprehensive practical training of industrial robot application programming”. The purpose of this comprehensive practical training is to be familiar with all the knowledge points and skill assessment points required for certificate assessment, and to participate in the 1+X assessment. For non industrial robot technology majors, because the professional elective course "Industrial Robot Application Programming" has been opened, there is no need to add this practical training separately.

Strengthening before examination: strengthening before examination requires the participation of every student who participates in the certificate examination, which can effectively improve students' passing rate of the examination. For students majoring in industrial robotics, need to add 10 credit hours of assessment intensive before the exam, for students of non industrial robot technology majors, need to add 30 credit hours of intensive practical training, mainly to sort out the skill points before the exam and strengthen the practical practical training. The strengthening before examination is implemented within 1 month before the examination, which will not affect the teaching order or occupy normal teaching time, mainly carried out in spare time and weekend time.

4. Assessment system integration

The course assessment mechanism is completely different from the X certificate assessment mechanism. The two differ greatly in assessment content, assessment form, and assessment requirements. In order to urge and encourage students to actively participate in the X certificate assessment, use "certificate for assessment" to reform curriculum assessment. For example, all students who have participated in and passed the "Industrial Robot Application Programming Vocational Skill Level Certificate" examination, students majoring in industrial robot technology are exempt from the examination of "Industrial Robot Maintenance and Repair" course, and students majoring in electrical automation technology are exempt from the examination of "Industrial Robot Application Programming" course.

5. 1+X assessment results

Yangling Vocational &Technical College, as a pilot unit for the 1+X vocational skill level certificate of "Industrial Robot Application Programming" and a provincial assessment management

center unit, completed the first assessment of the 1+X certificate in December 2020, where 30 people participated in the assessment, and the passing rate was 63.3% , The assessment results reflect the preliminary results of the book-certificate integration, and there are still many problems that need in-depth research and improvement to lay a good foundation for follow-up work.

6. Achievements of 1+X “curriculum-certificate integration”

6.1 “Curriculum-certificate integration” promotes reform of teachers, teaching methods and teaching materials

The 1+X pilot is a brand new program for schools, enterprises, and teachers, and there is no experience to follow. In the process of advancing the "curriculum-certificate integration", the "Double High-levels" Plan of the Ministry of Education's and the "1+X" pilot can be organically integrated, and the reform of "teachers, teaching materials, and teaching methods" can be promoted simultaneously. In response to the problems of unfamiliar 1+X assessment equipment and unclear assessment requirements, Yangling Vocational &Technical College has sent eight teachers to participate in the 1+X certificate teacher practical training for industrial robot application programming, laying a solid foundation for 1+X assessment.

There is textbook suitable for the "Industrial Robot Application Programming" course set up to cooperate with the "1+X" assessment teaching. Therefore, teachers have been organized to write a new loose-leaf textbook for project-based "Industrial Robot Application Programming" for teaching use. This textbook starts from the perspective of professional and technical personnel, takes the typical application cases of actual engineering as the main line, arranges projects and tasks around the work tasks and skill assessment points in Table 1, and strives to improve the professional authenticity and readability of the textbook.

In the course of formulating the curriculum-certificate integration plan, the course teaching team fully understand the significance and connotation of the "1+X" certificate pilot, transform and improve teachers’ teaching concepts, vocational education become more standardized and orderly, and the teaching effect is significantly improved. In the teaching process, the "UMOOC" platform is used to reform teaching methods, carry out online and offline mixed teaching, and use the "lab open plan" and "interest group plan" in the free time to make use of students' fragmented time and free time, to provide students with more practice time before the exam.

6.2 “Curriculum-certificate integration” promotes management system construction

The 1+X certificate pilot puts forward new requirements for schools’ related management system and promotes the construction of schools’ internal quality assurance system. It is also necessary to accelerate the construction of the 1+X pilot operation mechanism, the 1+X certificate and the credit bank integration management mechanism, and the establishment of the 1+X assessment special fund management system to ensure the system for the follow-up "1+X" pilot.

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