

# *Construction of Four-in-One Model of "Three Complete Education" in the Course "Industrial Robot Technology"*

Fulai Cao\*, Yu Ge

*College of Mechatronics, Xuchang University, Xuchang, 461000, China*

*\*Corresponding author*

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**Abstract:** Nowadays, there is an extreme shortage of industrial robot technical talents. To cultivate outstanding high-quality industrial robot technical talents, higher requirements are raised for the course teaching of "Industrial Robot Technology". Based on the course teaching of "Industrial Robot Technology", this study constructed and implemented three "four-in-one" systems of all-member, whole-process and all-round education innovation, achieving significant improvement in the accomplishment of course objectives after the implementation. The four-in-one model of "three complete education" can stimulate students' learning potential, improve teaching quality, and facilitate the effective completion of course objectives.

## 1. Introduction

The education reform of "three complete education" serves as a concrete embodiment of implementing the guidance of the CPC Central Committee and the State Council on education, which is an inevitable way for China to comprehensively advance the construction of "major ideological and political course". With the introduction of policy documents like "Made in China 2025" and "The 12th Five-Year Plan for the Development of China's High-end Equipment Manufacturing Industry", China's manufacturing industry ushers in a stage of rapid development. Increasing reliance on industrial robots develops in fields of automobile manufacturing, engineering construction, petrochemical industry, etc., leading to increasing demand for talents. However, China has an extreme shortage of industrial robot technical talents, so cultivation of outstanding high-quality industrial robot technical talents is an important support for building a manufacturing power. In order to implement the fundamental task of "fostering virtue through education, imparting knowledge and educating people" [1], according to the school's educational orientation of cultivating applied talents, Xuchang University constructs a new pattern of "three complete education" to advance the comprehensive reform research on "three complete education" in "Industrial Robot Technology".

## 2. Course Introduction

“Industrial Robot Technology” is mainly to teach technical parameters of industrial robots, mechanical structure design, modeling and kinematic simulation, sensing system design, trajectory planning and application. With strong comprehensiveness, the course content covers 3D mechanical design, mechanical transmission, electrical control, servo control, intelligent sensor, etc., focusing on both theory and practice. In view of the great difficulty in course learning, how to establish a reasonable and complete education system to effectively help students accomplish the course learning task with high quality is the focus of this paper. Starting from the professional background and characteristics of the course, the research group takes the teaching philosophy of CDIO and "major ideological and political course" as the guidance, advocates all-member, whole-process and all-round quality education. Based on cultivation requirements of BIM skilled talents, the education objectives of the course are subdivided into knowledge objectives, ability objectives and quality objectives as shown in Table 1 [2].

Table 1: Education objectives of “Industrial Robot Technology”

Knowledge objective	Ability objective	Quality objective
Students should master basic knowledge of industrial robot, structure form, DH parameter method; Master the modeling motion and simulation of industrial robots; Master the teaching demonstration and programming of industrial robots, as well as path and trajectory planning.	Example text 1 Students should be able to design and select the structural scheme of industrial robots according to the application scenarios; use DH parameter method to complete the modeling and kinematics solution of industrial robots; use robot teaching demonstration and programming to control the space trajectory according to the task requirements.	Through the course learning, let students develop innovation ability and scientific spirit of perseverance; develop the spirit of craftsman and professional literacy of safety awareness; learn ethical philosophy of dialectics and ethical relations; develop socialist core values and national patriotism.

## 3. Construct the Four-In-One Model of "Three Complete Education"

In order to implement all-member collaborative education, education with whole-process coverage and education with all-round penetration, and to learn students’ difficulties in the course learning process, the research group distributed questionnaires to 526 students of mechanical major in grades 2017 and 2018. Analysis was made on shortcomings of the course in all-member, whole-process, all-round education to put forward some suggestions and guidance for reasonable course reform. Based on the actual circumstance of the course and relevant system regulations of the university, the research group built the four-in-one model of "three complete education".

### 3.1. Build "Four-In-One" All-Member Education Innovation System Involving University, Family, Society, Students

Firstly, this course fosters a multi-teacher teaching model of "1++1+N". The course team consists of ideological and political teacher, instructor and several specialized course teachers. Members of the teaching team collaboratively educate students. Ideological and political teachers guide the overall framework and teaching design of ideological and political course [3], instructors are mainly responsible for the discipline in students' daily classes and students' psychological

counseling, and specialized course teachers are responsible for the teaching of professional theoretical and practical knowledge to incorporate ideological and political elements in the major.

Secondly, family support is introduced to effectively use family resources. Industrial robots are highly associated with the manufacturing process of products used in people's daily life. Students are encouraged to communicate with family members about the professional knowledge learned at school, so that parents can learn the students' learning status at school. Meanwhile, family members with relevant industry background are invited to learn the course and share their experience and harvest in the job.

Finally, enterprise interaction module is added. On the one hand, relevant enterprises and public institutions such as Anhui EFORT Intelligent Equipment Co., LTD., Senyuan Heavy Industry Co., Ltd. and other technical elites are invited into the class to introduce the latest research results and applications of the enterprises, which stimulates students' learning interest and also deepens the class depth [4]. On the other hand, through professional practice, students can enter the factory, observe the actual production process of enterprises, thereby truly understanding the actual production application of enterprises. Finally, the research group teachers carry out study and research at the front line of the industry, discuss talent training model with enterprises, listen to the needs of enterprises, and formulate enterprise cases appropriate for classroom teaching.

### **3.2. Build a "Four-in-One" Whole-Process Education Innovation System Covering Guidance on Learning, Lecture, Learning Supervision and Evaluation**

Guidance on learning is to extend the class width. By giving full play to the role of learning platforms like the Superstar, course-related learning resources and pre-class learning task list are distributed through the learning platform beforehand, so that students can learn with purpose and listen to the class with focus in the offline learning [5]. After finishing the pre-class learning tasks, students can test their learning status through pre-class tests. Teachers analyze students' error-prone points and knowledge difficulties through the platform data, so that offline teaching has a focus. According to the pre-class task point video and test completion status, the resources provided by this unit can be analyzed in terms of rationality, and students' feedback opinions and suggestions can be timely grasped, so that classroom teaching design can be timely adjusted.

Lecture refers to classroom teaching that firmly implements the objective of "foster virtue through education". It is necessary to earnestly design each link of classroom teaching, complete professional knowledge teaching and ideological value guidance with a focus and purpose, thus fully embodying the classroom teaching function [6]. For instance, students nowadays favor short videos, many of whom also shoot and edit short videos after class. It is possible to make short videos of "One-minute introduction to industrial robots" in the first class as an introduction to the new course. In the interpretation of industrial robot decelerator, short video can be made to describe how Professor Zhang Yuemin's team overcame obstacles in the full set of industrialization technologies of RV decelerator design, manufacturing, detection and testing of industrial robot, and broke the 30-year technological monopoly of Japan. It encourages students to grasp the core technology and enhances their sense of mission and responsibility of building a power in science and technology.

Learning supervision is to strengthen the guidance and supervision of students' learning through the four aspects of course teachers, academic tutors and class teachers. Course teachers should carry out learning exchange activities when appropriate, provide separate tutorship for students with big academic problems and check their learning status. Academic tutors should give directions on course selection and learning methods, train students as research assistants, and urge students to sustainably improve their scientific literacy and innovation ability [7]. Through regular class

sessions, dormitory visits and other ways, class teachers should communicate with students about study, life in and out of class, etc.

Learning evaluation is to improve the course evaluation mode. According to the concept of international engineering education certification, the course team should focus on process assessment and students' comprehensive quality cultivation. The assessment should shift from the previous single final examination to multi-faceted assessment of the digestion and absorption of knowledge objectives, the regeneration of ability objectives and the embodiment of quality objectives [8]. The digestion and absorption of knowledge objectives should be examined via examination papers and experiments. The examination papers mainly examine students' mastery of basic knowledge including industrial robot technology parameters, structure design, motion planning, and so on. Experiment mainly tests whether student can use robot trajectory planning knowledge and teaching programming methods. The ability objective regeneration assessment is completed through students' self-designed experiments. According to specific application scenarios in industry, the robot system solutions are initially designed, and the robot shall be able to perform specific functions based on self-teaching programming. The quality objective assessment is mainly accomplished from two aspects. One is to make assessment through students' perception in the special class activity "Robot Character File Story". The other is to assess through whether students' performance in the practical operation reflects safety awareness, professional norms and professional quality.

### **3.3. Build a "Four-in-One" All-Round Education Innovation System Covering Industrial Development Planning, Textbook Knowledge Update, Teaching Method Innovation and Reform Practice Program**

In terms of industrial planning, through the interpretation of documents such as "Made in China 2025", "The 14th Five-Year Plan for Robot Industry Development", it is necessary to clarify the development plan of industrial robot industry, introduce the development status of industrial robot, help students understand the demand for talents and technology in the field of domestic industrial robot, thus guiding students' future career selection, cultivating "four self-confidence" among students, strengthening the sense of mission and responsibility of building a science and technology power [9].

In terms of textbook knowledge update, it is necessary to timely update the textbook knowledge according to the development policies and standards of the industry, emphasize the combination of theoretical knowledge and engineering application of robotics, reduce the class hours of kinematics and dynamics, mechanical system design as appropriate in the course on the premise of guaranteeing the teaching quality. There is need to add the latest engineering application cases of industrial robots, such as cases about the in-depth integration of frontier technologies like intelligent manufacturing, Internet of things with industrial robots, to strengthen the cultivation of engineering application ability in robot technology.

In terms of teaching methods, it is necessary to give play to students' initiative, provide less but better heuristic teaching, incorporate effective modern technology, new teaching methods and ideological and political elements into classroom teaching to meet the trinity teaching objectives of "value shaping, ability cultivation and knowledge teaching" and improve teaching effects [10]. For example, the first chapter of this course illustrates the development of industrial robots by designing micro-class on development status of industrial robots and uploading it to the Superstar platform, which not only extends the class in time and space, but also enables students to participate in the class anytime and anywhere, thus increasing students' stickiness to the class. After class, students

are encouraged to actively participate in the open lab, in which student teams cooperate with each other to make a variety of robots through the Creative Star platform.

It is necessary to flexibly develop creative practical projects in project practice. Based on trajectory planning, operation and programming of industrial robots, a comprehensive training project can be carried out on the eve of May 4th Youth Day through project teaching method and group teaching method. Students can comprehensively utilize what they have learned, cooperatively complete the writing of the five characters "May 4th Youth Day" through two mechanical arms. Each group of students should work together to complete the prescribed tasks and compose the task report, which trains students' ability to use knowledge and also lets students spend an unforgettable holiday, thus unconsciously developing the craftsman spirit and patriotic feelings in students' hearts.

#### 4. Implementation Effect

The achievement of the course objectives is evaluated by quantitative and qualitative evaluation, and the minimum value of the two is taken as the accomplishment degree of the course objectives. In the semester 2021, the course reform was not implemented among the 115 students in grade 2018. In the semester 2122, 118 students of grade 2019 participated in the whole course reform. The accomplishment of course objectives in the two is compared as shown in Figure 1. After the implementation of the four-in-one model of "three complete education", great improvement is made in the knowledge, ability and education objectives of the course, achieving remarkable reform effect.

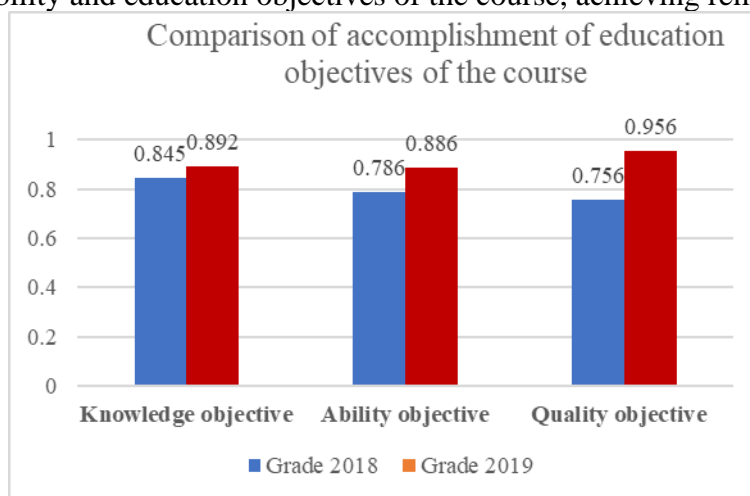


Figure 1: Comparison of accomplishment of education objectives of the course

#### 5. Conclusion

Industrial robot plays an important role in the development of intelligent manufacturing equipment and provides an important support for building a manufacturing power, which raises higher requirements for the course teaching of "Industrial Robot Technology". Hence, when implementing the fundamental task of "fostering virtue through education, imparting knowledge and educating people", we should adhere to all-member, whole-process quality education, effectively incorporate ideological value into every link of course teaching. By building three "four-in-one" education systems under the concept of "three complete education", it is possible to stimulate students' learning potential, improve teaching quality and effectively accomplish course objectives.

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