International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2019): 7.583

The Practice Research of Action-Oriented Teaching Methods in Secondary Vocation Education taking- "Operation, Maintenance and Programming of Industrial Robot" as an Example

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Abstract: ***Aiming at the deficiency of traditional teaching in Secondary Vocational Schools, action-oriented teaching method should be adopted in the practical teaching of the course "operation, maintenance and programming of industrial robots". First of all, this paper explains the course positioning, and then the teaching objectives, contents and practice process are designed. The results of curriculum implementation show that students have acquired professional knowledge related to industrial robots. It has developed professional skills related to industrial robots, and effectively trained the technical talents of operation, maintenance and programming of industrial robots.***

Keywords: Secondary vocational school; operation, maintenance and programming of industrial robot; Action-Oriented teaching method

1. Introduction

At present, China's traditional manufacturing industry is in the stage of transition from labor-intensive to technology-intensive. In the production process, industrial robots have the advantages of high work efficiency, good stability, high repetition accuracy and being able to work in dangerous environment. Many factories of enterprises begin to use industrial robots to replace human beings for production work. As a result, factories are demanding more skilled workers who can operate industrial robots. In the face of this increase in demand, secondary vocational schools began to set up courses related to industrial robots, training industrial robot operation and maintenance and programming technical personnel. However, the students trained by the traditional "pass-through" teaching mode cannot meet the requirements of enterprises and society. The action-oriented teaching method of vocational education always focuses on the cultivation of vocational action ability and takes the action of vocational work process as the direction of teaching, which can achieve the goal of improving students' learning interest, cultivating students' self-study ability and constructing their own knowledge and skills system. In order to enable the students to be more competent in the future, the action-oriented teaching method was introduced into the course of industrial robot operation maintenance and programming in the secondary vocational school.

1) Course orientation

Robotics technology is a comprehensive technology integrating multiple disciplines, involving automatic control, computers, sensors, artificial intelligence, electronic technology and mechanical engineering, and other contents. "Industrial robot operation, maintenance and programming" is an important professional course of mechanical and electrical major in secondary vocational school, because this course involves more and more complex professional knowledge. Therefore, the secondary vocational mechanical and electrical students in the "electrical technology", "electronic technology", "detection and instrumentation system installation and debugging", "automatic mechanical maintenance technology", "programmable controller technology and application" and other courses began to learn. The factory of many enterprises still has a great demand for the technical talents of industrial robot operation and maintenance and programming. The secondary vocational students learn this course well, which will lay a solid foundation for their future job hunting and employment.

2) The design idea and train of thought of action - oriented teaching method

Action orientation refers to "the action product (goal) jointly determined by teachers and students to guide the teaching organization process, students through active and comprehensive learning, to achieve the unity of mental and physical labor". It focuses on the cultivation of students' key abilities. Action oriented method, the basic meaning is: students are the central part of the learning process, teachers are the organizers of the learning process and the coordinator, follow the "information, planning, decision-making, implementation, examination, evaluation of" the complete sequence of "action" process, teacher and student interaction in the teaching, let the student through "independent access to information, independently plan, carry out the plan independently, independently assessment plan", in their own "hands-on" practice, master the professional skills and professional knowledge, to build belongs to the students' experience and knowledge system.

3) Teaching objectives

Through the study of this course , students can independently operate, program, control and maintain ABB industrial robots. In the process of teaching, students should study in groups so that students' sense and ability of

teamwork can be cultivated. The establishment of teaching objectives should focus on practical operation, using the project-leading and task-driven teaching mode, making full use of simulation software and practical equipment, combining theoretical knowledge with practical operation step by step and stimulating students' enthusiasm and initiative in learning in multiple dimensions.

Students' action ability after learning this course:①Basic operation of industrial robot includes the use of teaching device, basic operation of robot system, manual operation mode and coordinate setting of industrial robot.②Some basic knowledge of programming includes program module and rapid program, data type and operator, program flow control, robot basic motion control, I / O signal setting, editing and debugging of common functions and programs. ③Daily maintenance of industrial robots.

4) Teaching Content

After defining the teaching objectives of the course, we analyse of the industrial robot operation maintenance and programming job process and identify typical job tasks. According to the typical work task, we integrate the teaching content and design the corresponding teaching items. Under the teaching project, we design the corresponding teaching task. The teaching content is shown in figure 1:

Project 1：Knowledge of industrial robots	Project 2：ABB Robot programming fundamentals	Project 3：virtual modeling and simulation of industrial robots.	Project 4：Industrial robot handling	Project 5：Industrial robot diecasting	Project 6：Industrial robot welding
Task 1：composition and selection of industrial robots	Task 1：build a robot workstation	Task 1：Robot Studio Modeling functions	Task 1：understanding the composition of the multi-function training platform	Task 1：extrusion Process and Industrial robot diecasting programming	Task 1：Establishing Welding Robot System
Task 2：basic operation of ABB robot	Task 2：virtual teacher manual operation	Task 2：Smart application	Task 2：workpiece grab	Task 2：Simulation Design of Die-casting System	Task 2：robot Welding I/O configuration
	Task 3：create robot work piece coordinates and trajectory equations	Task 3：simple robot system creation and simulation	Task 3：Handling trajectory design		Task 3：Welding instructions programming

Figure 1: The Teaching Content

2. Teaching practice process of the course

Selection of teaching cases

The content of this course is based on project 4: industrial robot handling in the course of operation, maintenance and programming of industrial robots. This teaching case is conducted in the industrial robot training room of the school. The training room is equipped with industrial robot training platforms, computers and multimedia teaching equipments for programming, which is convenient for teachers' teaching and students' learning.

First, it creates the scenario corresponding to the actual production for project 4: industrial robot handling in the course of operation, maintenance and programming of industrial robots. Then project 4 is subdivided into three tasks, and each task is subdivided into several task objectives. Next it analyzes the teaching materials, and finally analyzes the students' foundation and the key and difficult points of teaching cases.

Teaching implementation process

The author chose Class 1 and 2 of Mechanical and Electrical 18 in Xuancheng Mechanical and Electronic Engineering School for teaching practice. Under the same conditions of teachers, contents and places of study, etc, action-oriented teaching was conducted for Class 1 Grade 18 of Mechanical and Electronic and traditional teaching was conducted for Class 2 Grade 18 of Mechanical and Electronic on December 25, 2019.The following is an introduction based on the specific teaching implementation process.

After starting the class, first, the teacher created a scenario by playing a video about industrial robots moving items in the actual production process, then the teacher began to arrange the project tasks for this class, which is industrial robot handling, and then began to complete the project tasks in groups. There are 40 students in Class 1 of Mechatronics at level 18, each group consists of 5 students, divided into 8 groups. After the grouping is completed, action-oriented teaching begins. The course of "Industrial Robot Operation, Maintenance and Programming" in the vocational school is mainly to learn through students' hands-on practice. Therefore, when choosing a teaching method, first choice is a brainstorming method that can quickly obtain different methods in a shorter time, then choose the project teaching method and task-driven teaching method that can improve students' key abilities and practical hands-on abilities. This is in accordance with the implementation process of action - oriented teaching practice.

Information

The teaching location of this class is selected in the industrial robot training room. The teacher must first explain to the students the learning goals of this class, because students can only find the learning direction if they understand the learning goals clearly, and the final teaching evaluation can also be based on learning targets. Then use multimedia teaching equipment to explain to the students the application of industrial robot handling in actual production, so as to explain that this class is in an important foundation position in the overall teaching of this course. This lesson will lay a solid foundation for future study. Then the teacher led the students to the multifunctional robot training platform to explain the structure of the multifunctional training platform for the students. Finally, emphasize to the students the specific tasks of this project and distribute some materials, so as to let students understand the multifunctional robot training platform and the projec.

Plan

The students sorted out and analysed the collected data and discussed with each other in the group. They analysed the project task requirements together, determined the project objectives, and made the work plan for the project task. In the process of making the plan, they could use the brainstorming method, and the team members worked out as many works plans as possible.

Decision making

During the planning stage, various teams generated different work plans through brainstorming. In order to find out the possible problems in the plan, team members discussed and analysed each work plan according to the requirements of the project tasks, and then analysed the possible problems which will make bad results. Group members discuss and find ways to solve problems, so as to decide the best work plan. The group leader will report the best work plan to the teacher, and then the teacher will evaluate it. The group will modify the best work plan according to the suggestions put forward by the teacher.

3. Implement

Task 1: understanding the the multi-function training platform

1) Understanding the composition of the multi-function training platform
2) Understanding the basic parameters and structure of ABB IRB120 robots and Mutsubishi FX3U-48MR PLC
3) Understand the basic composition of the conveyor belt module of the multifunctional training platform

Task 2: Workpiece grabbing

Mastering the gripping action control of the handling robot fixture. The training platform uses a robot-specific dual-function pneumatic fixture, Pneumatic fixture, also called pneumatic claw, is the use of compressed air as power, can achieve various grab functions, used to grab objects, pneumatic fixture is often used to handling industrial robots pick up and release objects. Before the handling robot grabs the workpiece, use compressed air as the power, open the fixture, after the fixture reaches the position where the workpiece is located, close the fixture and start to grab the workpiece.

Grasp the use of programmable keys ABB robot teache on ABB robot teache J、K、L、M are programmable keys;
J is the step-back button, press this button to make the program back to the first command;
K is the start button, start the program;
L is a step button, press this button to make the program forward to the next instruction;
M stop the button, stop the program.

Task 3: Handling trajectory design

1) Learn to write programs using basic robot motion instructions
- Basic motion instructions：Linear motion MoveL、Joint axis motion MoveJ 、Circular motion MoveC and Absolute position Motion Instruction MoveAbsJ.
- Basic Motion Instruction Format: movement mode target position, running speed, turning radius, tool center point.

2) Mastering the work flow of the handing robot in Figure 2:

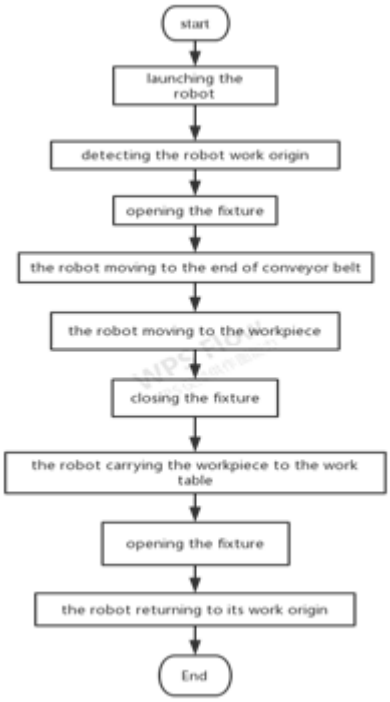

Figure 2: The work flow of the handing robot

3) Mastering the following program of the handing robot
MODULE MainModule
CONST robtarget
p90:=[[71.94,-501.49,292.27],[0.00195519,-0.704798,-0.709404,-0.00155926],[-1,0,0,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
CONST robtarget

```
p100:=[[211.66,-372.81,304.94],[0.00195502,-0.704802,-0.
7094,-0.00156055],[-1,0,0,],[9E+09,9E+09,9E+09,9E+09,9
E+09,9E+09]];
PROC main()
MoveAbsJ[[0,0,0,0,90,0],[9E+09,9E+09,9E+09,9E+09,9E+
09,9E+09,]]\NoEOffs,v500,z50,tools0;
Reset DO10_3;!
WaitDI DI10_1,I;!
MoveJ Offs(p90,0,0,50),v500,z10,tool0;!
MoveL,p90,v60,fine,tool0;!
WaitTime 1;!
Set DO10_3;!
WaitTime 1;!
MoveL Offs(p90,0,0,100),v50,fine,tool0;!
MoveL Offs(p100,0,0,100),v300,fine,tool0;!
MoveL p100 v50,fine,tool0;!
WaitTime 1;!
Reset DO10_3;!
WaitTime 1;!
MoveL Offs(p100,0,0,100),v50,fine.tool0;!
ENDPROC
ENDMULE
```

4. Evaluation

Teams put their own results demonstrate project tasks, team members according to the result of their own assess themselves and evaluate each other between groups. The teacher evaluates the results of each group, then each group summarizes the merit and shortage of place in the process of the project task and think the improvement method for the lack of places. The evaluation figure is shown in figure 2:

Work Results Checklist ___heat		
Task	Evaluation Content	evaluation rating
Task 1	understanding the composition of the multi-function training platform	
	understanding the basic parameters and structure of ABBIRB120robots and Mutsubishi FX3U-48MR PLC	
	understand the basic composition of the conveyor belt module of the multifunctional training platform	
Problem with Task 1		
Task 2	mastering the gripping action control of the handling robot fixture	
	mastering the use of ABB robot teacher programmable keys	
	mastering digital signal position and reset instructions	
Problem with Task2		
Task 3	learning to write programs using robot basic motion instructions	
	mastering the workflow of the handling robot	
	learn to write procedures for handling robots	
Problem with Task3		
Annotation: Evaluation rating is A,B,C,D level 4		

Figure 3: The evaluation figure

Teaching effect analysis

At the end of the project, the author designed a questionnaire with three objective questions to investigate students' satisfaction with action-oriented teaching, whether action-oriented teaching can improve students' learning effect and whether students adapt to action-oriented teaching.

Questionnaire data analysis

1. Students' satisfaction with action-oriented teaching

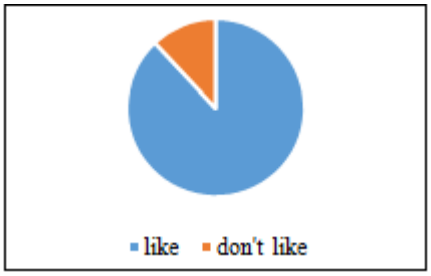

Figure 4: The percentage of students satisfied and dissatisfied with action-oriented teaching

2. Whether action-oriented teaching can improve the learning effect of students

Figure 5: The percentage of action-oriented teaching can improve the learning effect of students and can't

3. Whether students adapt to action-oriented teaching

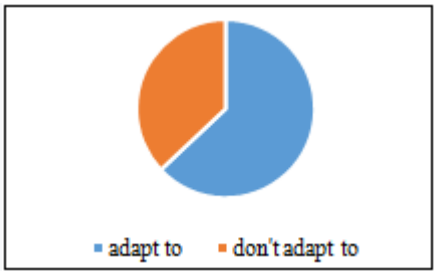

Figure 6: The percentage of students adapt to action-oriented teaching and don't adapt to

Performance assessment analysis

The author assessed the students after they finished the study of project 4: industrial robot handling. The method of assessment was theoretical test first, and then practical operation test. Among the total scores, the theoretical score accounted for 40%, and the practical operation score accounted for 60%.

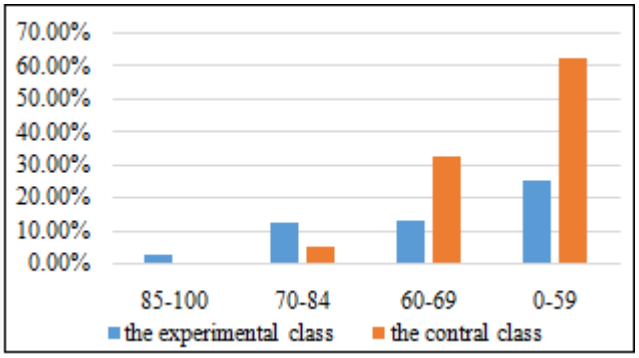

Figure 7: The scores of the experimental class and the contral class

Through the analysis of the statistical graph, it can be concluded that the teaching design of the action-oriented secondary vocational course "industrial robot operation and maintenance and programming" has significantly improved the students' performance compared with the traditional teaching in this course, and the number of students with medium academic performance in the class has increased significantly.

5. Conclusion

Action-oriented teaching method is helpful to secondary vocational students whose logical reasoning ability is not very strong. In the process of implementation, students can actively participate, the classroom atmosphere is active, a number of students began to ask questions, the teaching effect has been improved. Students rely on themselves to complete the project given by the teacher and the teacher timely helps in the side of them. Action-oriented teaching method in the specific application of the requirements on the teacher will be higher, first of all, the teacher should have enough professional knowledge, second, to have the actual processing and production experience in the factory, but also to be able to manage the classroom discipline ability. Therefore, the application of action-oriented teaching method is conducive to the improvement of both students' learning ability and teachers' teaching ability.

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