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Research on Teaching Mode Innovation of Engineering Practice Training Course in Colleges and Universities

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Abstract: *In the practical teaching of engineering training courses in colleges and universities, there are "pain points" such as lack of students' engineering awareness, lack of students' innovation ability, and lack of students' independent learning ability. The article takes students' development as the center and takes the teaching concept of "corporate culture and engineering literacy", and then designs the teaching mode of" combination of competition and training, online and offline ". This teaching design adopts the innovative method of combining engineering cases with teaching process, integrating simulation training with practical operation, and corresponding task design with ability improvement. Taking Automation Engineering Training Course as an example, the design and practice of the teaching process with distributed modules, progressive grades and standardized engineering can improve the quality of teaching and personnel training, which has certain promotion and application value.*

Keywords: *Engineering Rraining Course, Teaching Mode, Innovative Research*

1. Introduction

China's economy is developing rapidly with high quality to meet the needs of industrial transformation and upgrading. Colleges and universities need to improve the quality of talent training and teaching, and cultivate a large number of compound technical and skilled talents with innovative ability, engineering ability and craftsmanship spirit to better serve and contribute to the country and better move towards internationalization. The National Skills Competition held in 2020 will be connected with the World Skills Competition, so that the training site has the connotation of enterprise culture, and will be deeply connected with the engineering projects, aiming to cultivate highly skilled and innovative talents with engineering literacy who are required by social development. At the same time, in the context of the epidemic situation, the practical teaching of engineering training courses in colleges and universities has also posed new challenges. The online and offline teaching mode integrating information technology has become an important means of teaching.

Therefore, the "Automation Engineering Training Course" of the automation specialty of the school was carried out to "feel the pulse and diagnose the pain". Based on the problem oriented, student-centered, teaching concept of "corporate culture and engineering literacy", and the purpose of improving the quality of talent training, this paper analyzes the practical teaching of engineering training, expands the depth and breadth of practical teaching content, extends the time and space for learning, and studies and constructs a new teaching method based on the integration of engineering cases and teaching process, simulation training and practical operation Modular teaching content corresponding to module design and ability improvement. In the engineering practice teaching, ideological and political education and information technology are integrated, classroom flipped teaching methods and means are used to carry out innovative design and practice of the "combination of competition and training, online and offline" teaching mode, and build a modular distributed [1], hierarchical and standardized engineering teaching process. Practice has proved that it has improved the students' engineering awareness and ability, innovation ability, autonomous learning ability and craftsmanship spirit, thereby improving the quality of teaching and talent training, and has certain promotion and application value [2].

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2. Problems in practical teaching of engineering training in colleges and universities

2.1 Student's weak engineering awareness

At present, some engineering training courses in colleges and universities focus on cultivating students' skill level. There is still a certain distance between the setting of engineering training courses and the post requirements of enterprises. There is a lack of overall engineering management concept, a lack of production process concept, a lack of personal feelings about production efficiency and work efficiency, and a lack of training students' engineering awareness, leading to insufficient post capacity.

2.2 Inadequate innovation ability of students

The engineering training courses in most colleges and universities are still based on the original experimental training equipment for practical learning. The students rely heavily on the equipment and have a fixed mind. They do not have the breadth and depth of engineering knowledge, nor the cutting-edge technology. They cannot carry out technology transplantation and innovation, which leads to insufficient innovation ability of students.

2.3 Students' self-study ability is not strong

The content of traditional engineering training courses is based on the integration of textbook knowledge and teaching equipment. Most of them are practical operations to verify the principle, and the learning process is boring. There is a lack of teachers for practical teaching, so we can't provide timely guidance to students at any time. The curriculum is highly dependent on hardware equipment, so we can't learn anytime and anywhere, and the self-study conditions are not perfect. Many factors lead students to be not interested in traditional engineering training courses, and their self-study ability is not strong.

2.4 Students lack craftsmanship

In the teaching process, the ideological and political elements are insufficient or lack of innovation, the assessment and evaluation methods are single, and the process evaluation and check are not paid attention to. The students do not understand the craftsmanship spirit of striving for perfection enough. Many students do not pursue striving for perfection with the goal of completing work tasks and obtaining credits.

3. Construction of the teaching mode of "combination of competition and training, online and offline"

Aiming at the problems existing in the practical teaching of engineering training in colleges and universities, the teaching mode of "combination of competition and training, online and offline" is innovated with the teaching concept of "enterprise culture and engineering literacy". The teaching design is based on the combination of engineering cases and teaching process, the integration of simulation training and practical operation, and the corresponding task design and ability improvement. Taking the Automation Engineering Training Course as an example, the enterprise culture is integrated into the design atmosphere of the engineering training area, the skills competition project and the engineering training project are integrated into the design, and the information technology application online and offline teaching forms a student centered engineering training practice learning model [3].

3.1 Design of Course Concept and Objectives

The curriculum concept focuses on the development of students, strengthens basic skills and professional quality, focuses on the expansion of engineering application ability, focuses on cultivating students' innovative practical ability, and focuses on the self-learning ability of future new technologies and the ability to adapt to jobs. Aiming at the needs of employers, we should focus on cultivating the craftsmanship spirit of students' excellence, combine it with the needs of vocational teachers' ability to teach and educate people, and cultivate new vocational education teachers' education talents who master high-level operating skills and a high sense of responsibility. Integrate professional ability and engineering ability, shorten the distance between schools and enterprises, and cultivate new engineering technicians who can quickly integrate into their posts [4]. Finally, the comprehensive practical teaching

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concept of "corporate culture and engineering literacy" is formed.

The goal of curriculum objective knowledge is to combine the theoretical knowledge and skill practice of professional courses, guide and plan practical activities with theoretical knowledge, consolidate and sublimate theoretical knowledge with practical activities, and form a real integrated teaching form of theory and practice. The ability goal is to carry out the teaching implementation process of distributed modules, progressive skill levels and standardized engineering standards in combination with enterprise engineering cases, so as to cultivate students' engineering practice ability, ability to independently analyze and solve problems, teacher education ability and innovation ability. The emotional goal is to cultivate students' labor fashion of advocating skills and loving skills, enhance engineering awareness, cultivate innovation awareness and craftsmanship spirit, and embody students' emotional value in self-confidence, interest, attitude and responsibility, based on moral cultivation.

3.2 Modular design of course content

Under the background of the new engineering discipline, the course content is designed innovatively in two dimensions: breadth and depth. The "four in one" teaching mode is problem oriented, with the concept of "corporate culture engineering literacy", with students' offline practice as the main and online simulation as the auxiliary [5] . In combination with the actual typical production projects of the project and the national skills competition projects, the teaching innovation design is modular, progressive and standardized, Four modules are extracted, namely, electromechanical engineering practice, industrial robot technology application, modular PLC control system design and double closed loop DC speed regulation system debugging and maintenance, which are arranged for 60 class hours, 90 class hours, 60 class hours and 90 class hours respectively. Mechanical and electrical engineering practice projects, based on the connection between engineering production practice and teaching process, shorten the distance between course teaching and enterprise posts, and integrate the new standards of enterprise engineering; The application project of industrial robot technology is relatively close to the development of science and technology by industrial transformation and upgrading and teaching process, and meets the new needs of industrial development; The design project of modular PLC control system brings the distance between the discipline competition and the discipline competition closer with the competition system incentive and teaching process, corresponding to the new progress of discipline research; The commissioning and maintenance project of the double closed loop DC speed regulating system has brought it closer to the production management by virtue of safety and health, equipment operation and maintenance and teaching process, and accumulated new experience in enterprise development [6]. The modular design model of course content is shown in Figure 1.

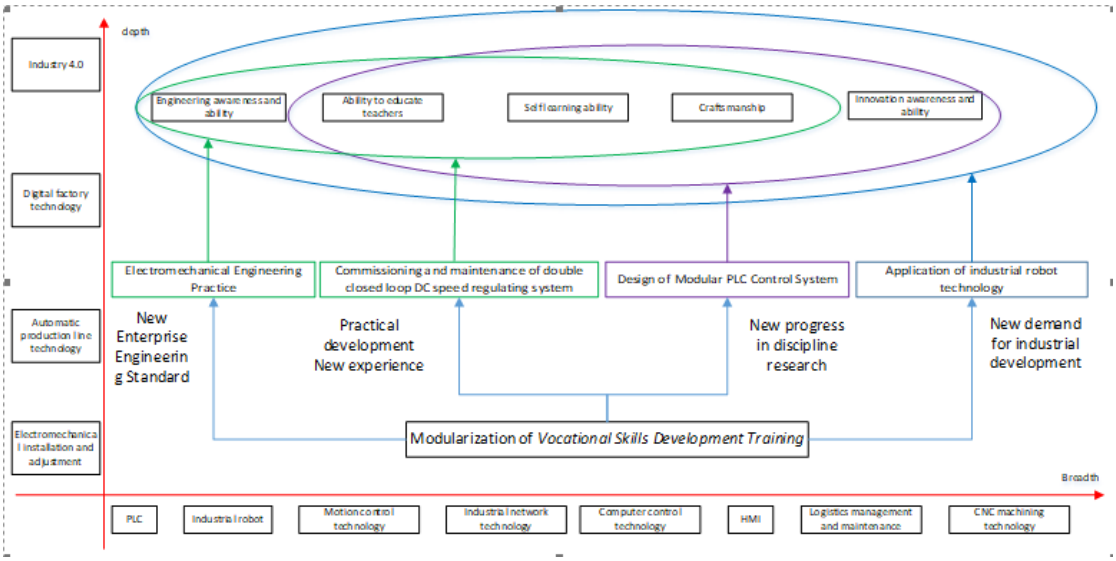

Figure 1: Design of teaching content model of Automation Engineering Training Course

3.3 Course teaching process design

In the teaching process, a "four in one" teaching mode is formed, which combines theory with practice, innovation and development, competition with training and integration of production and teaching.

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Students are the main body, teachers are the organizers, focusing on teaching students in accordance with their aptitude and role transformation; Mastering the development of individuality and realizing complementary advantages; Integrate information technology to realize classroom turnover; The teacher guides the students on tour, and the students actively discuss, carry out engineering practice teaching, and comprehensively improve the students' engineering ability, innovation ability, craftsmanship spirit, independent learning ability and other comprehensive abilities [7].

Taking the "Application of Industrial Robot Technology" module as an example, the teaching process is designed in the training environment with enterprise culture. In Figure 1, it is clearly stated that the characteristics of different tasks aim at different abilities. The improvement of autonomous learning ability runs through the whole process of tasks. Some tasks of the project can be simulated online, such as engineering design, and some tasks must be completed offline, such as mechanical and electrical installation engineering specification practice. Therefore, the combination of online and offline can flip the classroom and improve the teaching quality. The application of information technology, such as simulation platform, Digital Signs resources and digital twins: (1) It can solve the problem that students can learn when they are not in school or in the workshop; (2) Flexible allocation of learning time before, during and after class; (3) The drawings, manuals, videos and other teaching resources stored on the electronic signage platform of each equipment effectively solve the problem of teachers. These designs realize that the classroom teaching is student led and teacher guided, which can stimulate students' interest in learning and improve students' autonomous learning ability.

The whole teaching process takes the task decomposition of typical engineering cases as the main line, and innovates teaching methods for task driven learning. The whole teaching process takes typical project case task decomposition as the main line, and carries out task driven learning. For example, in Task 2, engineering standards were introduced into the TCP precision measurement training to encourage students to challenge the limits and cultivate the craftsmanship spirit of excellence through competition; The third task is to draw the movement track, use the combination of performing arts and engineering technology to activate the classroom atmosphere and stimulate students' interest.

3.4 Course teaching evaluation design

Each module of the course carries out process and result based teaching evaluation, focusing on students' self-evaluation and mutual evaluation. In combination with various evaluation methods such as project acceptance, game breakthrough, speech mutual evaluation, competition incentive, etc., students' innovation ability, independent learning ability, and engineering practice ability are examined in an all-round way, while promoting the cultivation of craftsmanship and labor quality. This course has a total of 300 class hours, 30 classes per week time teaching, 10 teaching weeks in total. Total course score=（ΣWeekly module scores/number of weeks) * 20, 90-100 points are excellent, 80-89 points are good, 70-79 points are medium, 60-69 points are pass, and below 60 points are fail. Table 1 shows the evaluation based on the teaching content of the "Industrial Robot Technology Application Project". The scores of each teaching week are: 30% for working hours (A), 40% for process records (B), and 30% for training reports (C). Each score is calculated in the percentile system, so the weekly score=A * 30%+B * 40%+C * 30%. Among them, process evaluation (B) includes 20 points for attitude performance, 40 points for mastery and result evaluation, that is, process evaluation (B)=attitude performance score+mastery score+result evaluation score, as shown in Figure 2. Table 1 shows the teaching evaluation contents of the application module of industrial robot technology.

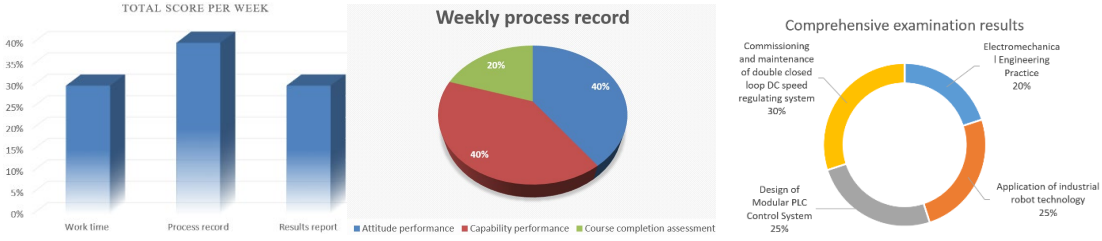

Figure 2: Evaluation of Course Teaching Design

Take the "Application of Industrial Robot Technology" module as an example to design the content of teaching evaluation, as shown in Table 1.

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Table 1: Teaching Evaluation Content of "Industrial Robot Technology Application"

Task No.	Task Name	Process Evaluation Content	Result Evaluation Content
1	Engineering Design and Assembly	Professional quality (attendance, attitude performance) Safe and normative operation	Engineering Drawing Standards Code of Engineering Practice
2	Teaching operation and coordinate calibration	Professional quality (attendance, attitude performance) Safety and correctness of teaching pendant operation	Correct posture and position adjustment TCP accuracy measurement
3	Draw Motion Tracks	Professional quality (attendance, attitude performance) Proficiency in teaching pendant operation	Smooth and correct trajectory Training report
4	Programming and debugging of handling workstation	Professional quality (attendance, attitude performance) Logic and correctness of programming	The simulation logic of the training report is correc technological process
5	Engineering Practice of Stacking Workstation	Professional quality (attendance, attitude performance) Project standardization	Innovation of stacking method Training report
6	Operation and maintenance of industrial robot system	Professional quality (attendance, attitude performance) system operation	Correct adjustment and maintenance

4. Solve the "pain point" problem and improve the quality of achievements

Through the teaching innovation of the curriculum, each teaching module has improved the teaching quality and teaching effect in different aspects. The improvement of teaching quality is mainly reflected in the following aspects.

4.1 Integrate into ideological and political education and cultivate craftsman spirit

As shown in Figure 3, taking the industrial robot "TCP precision measurement" as an example, ideological and political elements and content are integrated in the teaching process to cultivate the craftsmanship spirit of students.

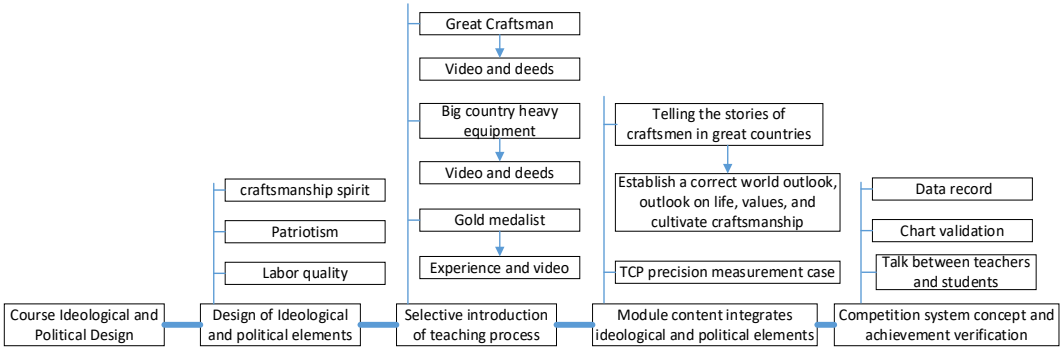

Figure 3: Integration of Ideological and Political Elements into the Teaching Process

Take "Robot TCP accuracy measurement" as an example, the error is generally required to be 0.5mm. In teaching, students are constantly challenging limits, breaking records and pursuing excellence. As shown in Figure 4 and Table 2, the recorded data prove that the measurement qualification rate has increased from 60% to 87%, and the excellence rate has increased from 14% to 60%. In teaching, teachers and students communicate and experience feedback, fully affirming that ideological and political elements are imperceptible, internalized in the mind, externalized in the form, and materialized in the practice, promoting the cultivation of students' craftsmanship spirit and labor quality.

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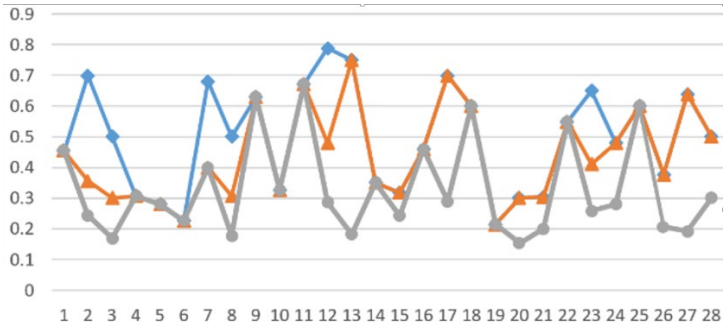

Figure 4: TCP Measurement Error Data Distribution

Table 2: Statistics of TCP Measurement Error Results

Measurement sequence	Average value (mm)	Pass rate (%)	Excellent rate (%)
1	0.494	60.7	14.2
2	0.438	75.0	17.8
3	0.330	85.7	60.7

4.2 Integrate information technology to improve teaching efficiency

According to the requirements of engineering specifications, the virtual simulation platform and digital twin simulation factory shown in Figure 5 and Figure 6 enable students to fully understand the actual scene of the project and conduct simulation learning, which largely solves the problems of students' slow start, lack of engineering safety awareness, high equipment cost, few engineering cases and insufficient space. Practice has proved that it provides convenient conditions for engineering practice teaching, promotes the cultivation of engineering awareness, and significantly improves teaching efficiency.

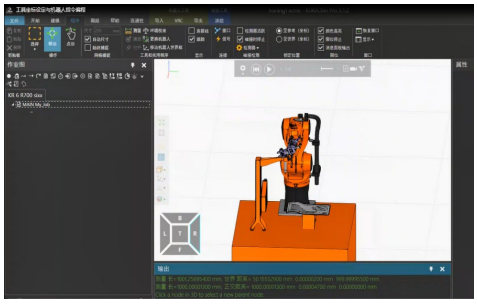

Figure 5: Virtual Simulation Software Teaching

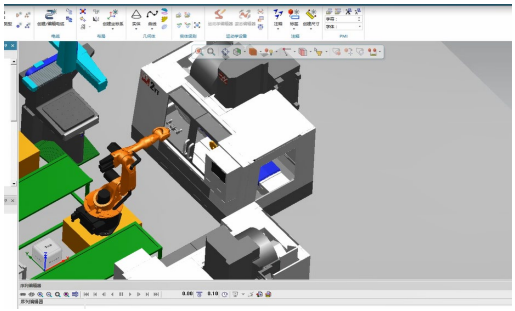

Figure 6: Digital Twin Virtual Factory

The three-dimensional network teaching resources break the limit of learning time and space, and realize the independent online tutoring teaching for each student. Students can choose the current required courses according to their own learning progress. On the basis of ensuring the classroom learning progress, students who have spare efforts can also learn independently to improve the teaching efficiency.

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4.3 Creative teaching methods to stimulate learning interest

For example, by using the teaching methods of dancing and games, the originally tedious, boring and boring engineering practice classroom has been turned into a stage for self demonstration, creating a relaxed and positive classroom atmosphere, stimulating students' interest in learning, and improving their independent learning and innovation ability while mastering the engineering norms.

4.4 Focus on achievements transformation and promote all-round development

Combine theory with practice, focus on leading students to digest, absorb and apply professional knowledge, encourage students to organically combine theoretical knowledge with practical activities, provide students with visual standards, guide students to practice and learn normatively, promote students' all-round development, and lay a good foundation for future professional activities.

Innovative development, encouraging students to innovate in the design of teaching content and teaching equipment. Many students have participated in equipment development, handout adaptation, case and question bank compilation, etc. The equipment designed has applied for patents and transformed products, some of which have been applied to school training and teaching.

The combination of competition and training enables the courses to seamlessly connect with the disciplines and skills competition. In the first vocational skills competition of the People's Republic of China, two students won the gold medal of the Industry 4.0 project with the first place, and two students won the robot system integration project winning prize.

Integration of production and education, the innovative engineering practice training course integrating enterprise engineering specifications, has been promoted in the enterprise staff and teacher training and achieved good results.

5. Conclusion

Focusing on the development of students, according to the demand for technical talents in the new era, we carefully sorted out the "pain points" in teaching. Guided by the lack of craftsmanship, engineering awareness, independent learning ability, innovation ability and other issues, we integrated ideological and political elements, engineering cases and information technology, and made innovations in teaching content, mode, method and evaluation based on education and teaching theories. Finally, the teaching practice proved that the "pain point" problem was further solved, the teaching quality and effect were significantly improved, and the students' comprehensive ability was gradually improved. The curriculum teaching reform effectively improves the teaching quality and talent training quality, and has certain radiation effect and promotion value.

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