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Research on the Training of Highly Skilled Talents Based on Industrial Robot Professional Skills Competition

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Abstract: In the research and practice of talent cultivation in the electromechanical robot professional skill contest, the author found that good vocational skill orientation is the key to talent cultivation of students in higher vocational and technical colleges. The vocational skills competition held by colleges and universities, on the one hand, makes up for some possible shortcomings in teaching, on the other hand, provides students with effective training opportunities and a stage to fully demonstrate their abilities.

1. Introduction

Under the background of the "Fourteenth Five-Year Plan" of national education and the active training of application-oriented talents in higher vocational colleges, the country has set up a national vocational skills competition, and major colleges and universities have actively responded to the call of the country. Various vocational skills competition activities have been carried out in full swing, and active personnel training policies have been carried out to build a platform for the research and practice of teaching and talent training.

Mechatronics and industrial robots, as the characteristic specialties of intelligent manufacturing, are receiving more and more attention from higher vocational colleges under the continuous development of China's industrialization process. The establishment of teaching talent training programs for such specialties as mechatronics and industrial robots has demonstrated the necessity and significance of domestic market demand.

2. Professional Research Prospects

2.1. Current Situation Analysis

As China enters a new stage of development, industrial upgrading and economic restructuring continue to accelerate, the demand for skilled personnel in all walks of life is increasingly urgent,

and the important position and role of vocational education is increasingly prominent.

According to the statistical data of the National Bureau of Statistics in Figure 1, the number of general college graduates in 2021 accounted for 48.20% of the number of college graduates in China. However, for this part of students, the advantage of academic qualifications is not great. In this era of increasingly severe employment environment, colleges and universities should adjust the curriculum structure, strengthen the proportion and effect of vocational skills curriculum teaching, guide and help students find their own career orientation and find a good employment direction.

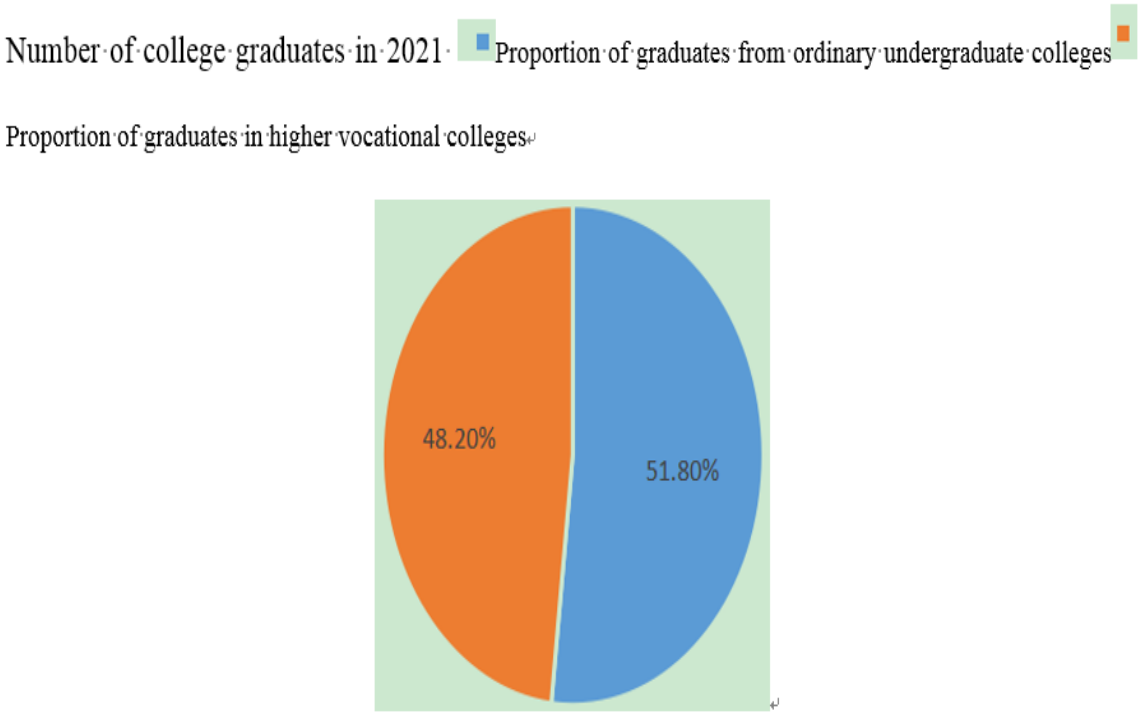

Figure 1: Pie chart of the proportion of graduates from ordinary undergraduate colleges and higher vocational colleges in 2021

2.2. Advantages of Teaching Reform-school-enterprise Cooperation

In today's era of rapid technological change, more vocational colleges and universities have chosen to deeply integrate with enterprises. With the help of the information and technological advantages of enterprises, they have trained skilled talents in line with the needs of the times and the development of enterprises, and continue to contribute to the popularization and promotion of the application of science and technology in China. It is very important for vocational education to encourage "integration of industry and education, cooperation between schools and enterprises", take various measures and policies, encourage integration of industry and education, and encourage enterprises to participate in teaching.

2.3. Professional Introduction

Taking the industrial robot technology in mechatronics technology as an example, we will discuss the professional teaching through the skills contest in vocational colleges.

Electromechanical integration technology is an important engineering system. It is a comprehensive technology that integrates electrical and electronic technology, mechanical technology, microelectronics technology, sensor technology, signal technology and other

technologies and applies them to actual production. Through in-depth research on mechatronics technology, people continue to improve mechanical properties and promote the production and development of new products.

3. Introduction to Vocational Skills Competition

3.1. Purpose of the Competition

Through the competition, test and display the teaching reform results of this major in higher vocational colleges and the general technology and professional ability of students, lead and promote the teaching reform of this major in higher vocational colleges, stimulate and mobilize the initiative and enthusiasm of the industry and enterprises to pay attention to and participate in the professional teaching reform, and promote the improvement of the training level of applied professional talents in higher vocational colleges.

The skills competition in vocational colleges can promote the development of vocational colleges and is of great significance for training talents. The vocational skills competition can cultivate students' interest in their majors and flexible use of their knowledge, and improve students' learning motivation; For teachers, it can enhance the professional skills of teachers and the level of teaching courses, at the same time, it can also promote the reform of professional courses in schools, so that students' majors can be integrated with the production of enterprises in society, so it can promote the deep integration of students, teachers, schools and enterprises, and truly implement the "integration of industry and education, school-enterprise cooperation".

3.2. Competition Content

The industrial robot competition in vocational college skill competitions is based on the industrial robot intelligent workstation system as the competition platform. Students are required to form teams to complete the following competition items. The first task is to complete basic tasks such as installation and debugging of supporting equipment and electromechanical systems. The second task is to complete the calibration of industrial robots and programming of teaching devices, communication settings and operation programming, programming and debugging of visual systems, programming and testing of AGV robots and stacking robots, and to develop controlling programs through the human-machine interface of the system. The third task is to complete the integration of online operation and specific manufacturing processes of the industrial robot intelligent workstation system.

The contents of the competition can not only enable students to fully understand and absorb the courses they have learned at school, but also promote the school to carry out teaching reform and achieve the goal of "promoting teaching, learning, innovation and cultivating craftsmen through competition."

3.2.1. Basic Items of Competition

See Table 1 for details of the basic events of the competition.

Table 1: Requirements for basic items and contents of the competition

No.	Requirements for competition items
1	Assemble AGV mobile robot, industrial robot fixture, gas pipe butt joint and cylinder to complete the competition
2	The camera is used to take pictures of the types, positions, angles and defects of various types of workpieces, then make samples and mark them, so as to realize the recognition of defective workpieces by the camera
3	Complete the test of the industrial robot fixture, the communication between the stacking PLC control cabinet and the main control cabinet, and the communication between the main control cabinet and the robot
4	Write PLC program to make it possible for the palletizing robot to accurately go to the correct warehouse location to grab the workpiece, and then send it to the AGV mobile robot, so that the AGV mobile robot can transport the workpiece to the workpiece identification location for workpiece defect identification

4. Research on Teaching Content Based on College Vocational Skills Competition

4.1. Build a New Talent Training System and Multi-level Competition Platform

Based on the national standards, a systematic teaching plan has been developed. Through the real simulation of enterprise project cases, the theoretical knowledge has been taught to students, and the practical operation ability of students has been improved. In the process of cultivating students' innovative ability, many of the concepts and educational concepts that have been stuck in theory before have been implemented step by step in the process of this kind of teaching. The ideological and political courses, 1+X (certificate), mixed teaching and so on have been better integrated and better practiced in the course of our competition.

Therefore, it is of great significance to build a new talent training system and a multi-level competition platform based on the skills competition in vocational colleges to cultivate students of independent colleges with solid basic theory, broad knowledge, strong practical innovation ability and high comprehensive quality.

4.2. Environmental Construction

4.2.1. Team Formation

Establishing a suitable team can cultivate students' communication ability and teamwork ability. The team is composed of three people, one is responsible for the on-site programming of the industrial robot, one is responsible for the PLC program of the stacking robot, one is responsible for the communication between the devices, the script preparation of the intelligent visual inspection system and the production of the standard workpiece sample.

4.2.2. Training Environment

In order to create an environment suitable for student training, our school has built an industrial robot training base.

The basic configuration of the training base includes: palletizing robot, three-dimensional warehouse, AGV mobile robot, workpiece assembly line unit, transfer assembly line unit, palletizing machine control cabinet, main control cabinet, six-axis industrial robot, intelligent visual inspection and recognition system, protective fence, and computer.

4.3. Training Mode Based on Skills Competition in Vocational Colleges

4.3.1. Theoretical Knowledge Syllabus

The specialty of industrial robot is based on "mechatronics technology" to cultivate new skilled talents engaged in the installation, commissioning, maintenance and repair of industrial robots and workstation systems. Students are required to understand the basic structure and movement principle of industrial robots, and master the skills of robot installation, debugging, programming, operation, maintenance and repair. See Table 2 for professional course types and content requirements

Table 2: Requirements for professional course types and contents

Course type	Specific course name
Professional basic courses	Mechanical drawing, mechanical design foundation, electrical and electronic technology, industrial robot technology foundation, C language programming, numerical control technology and application, mechanical CAD/CAM, machine tool electrical control and PLC technology, Protel circuit board design, and supporting experimental training
Professional core courses	Controllable programming control technology, off-line programming and simulation of industrial robot system, on-site programming of industrial robot, robot vision technology and application, industrial robot application system integration, industrial robot application system debugging and operation, industrial robot system maintenance, and supporting practical training

4.4. Combine the Contents of the Competition with the Courses Learned

After learning the professional basic courses and professional core courses, the teacher can organize students to go to the school's training base for training, and the students will form their own teams to carry out the training based on the competition items of the industrial robot competition.

4.4.1. Project I

Assemble the mechanical and electrical equipment as required, mainly the installation of the AGV mobile robot's conveyor track and motor, and the connection of the industrial robot's clamp and air pipe of the cylinder.

This project allows students to understand the conveying principle of the conveyor belt, and how the robot fixture and cylinder work.

4.4.2. Project II

The intelligent visual inspection and recognition system is to identify the workpiece through the camera, analyze the workpiece, and determine whether the workpiece is defective. This is a direction of the industrial robot vision technology. With the development of intelligent manufacturing in China, this technology will be popular in the future. Teaching students this technology in advance can make students competitive in the future employment, and learn relevant technology faster in the future.

When training this project, students first need to take photos of different types of standard workpieces at different angles, directions and positions to make standard samples. After taking a picture of the standard workpiece, students use the marking software to mark the picture, frame the key points, and make a sample. Then write the recognition script.

During the normal operation of the project: AGV mobile robot will transport the workpiece tray to the roller conveyor belt. When the workpiece tray is transported to the visual inspection and

sorting station, it will stop, and then the camera will take photos to identify the workpiece. If the workpiece is normal, it will be released, and the data will be transmitted through Ethernet to let the mechanical arm transfer the correct tool and prepare to grasp; if the workpiece is defective, ask AGV mobile robot to send the defective workpiece back to the warehouse.

This process can enable students to understand the basic principles of camera recognition technology, and also enable students to apply the programming learned in class to actual combat.

4.4.3. Project III

Complete the parameter setting of industrial machines, and then conduct field programming, which is the basis for operating industrial robots.

Before students operate industrial robots, they should first carry out practical safety education for students to clarify the safety issues of operating industrial robots:

1) Before operation, check whether the fixture on the flange plate of the mechanical arm is firm;

2) Check whether the teaching pendant is in manual mode;

3) When the robot operates automatically, there shall be no irrelevant (personnel, tools, articles) in the robot work area;

4) In case of emergency, immediately press the emergency stop button on the teaching pendant;

Before operating the industrial robot, you should set the tool coordinates - TCP (Tool Center Point) coordinates, because the tool coordinates of different fixtures are different. After setting the tool coordinates, set the payload of the tool.

After the preparation work is completed, you can carry out field programming. The main content of the programming is to write the motion path of different workpieces calling different tools to grab or clip to the spare parts library, and then write the motion path of assembling the workpieces in the spare parts library.

Through the third project, students can skillfully operate industrial robots and understand how industrial robots work. In the future, when students are employed in enterprises, no matter which brand of robots they need to operate, they can quickly start.

4.4.4. Item IV

Compile PLC program to control the stacker and AGV mobile robot, and carry out data interaction and communication with industrial robot, intelligent visual recognition system and stereoscopic warehouse through Ethernet.

The interactive interface of PLC is prepared to realize real-time monitoring of 28 positions in the stereoscopic warehouse. Each position has a vacancy detection switch. When the pallet of the position is taken away by people or by the stacking robot, it should be displayed on the screen on the PLC control cabinet of the stacking robot. The interactive interface also needs to make inching and moving functions for the stacking robot in X, Y and Z directions.

The fourth project can intuitively reflect the PLC programming effect that students have learned in class, which greatly strengthens students' understanding and interest in the course. The vacancy detection function of the three-dimensional warehouse allows students to intuitively feel the role of sensors in industrial production. The communication between devices can help students learn how to connect devices through Ethernet to realize linkage production, which is also something they must learn in future work.

4.5. Training of Students' psychological Quality

In order to participate in the skills competition in vocational colleges and achieve good results, students need not only solid theoretical basis and skill level, but also good psychological quality.

Only good psychological quality can meet unexpected problems in the competition to be calm and calm in the face of danger. Therefore, in addition to teaching students theoretical knowledge and professional skill training, teachers also need to cultivate students to have a positive attitude, Do not be conceited or discouraged. There are gains and losses in the competition. Only a positive attitude can let students put themselves in the right position. Don't be proud if you win. You should continue to keep it; Don't be discouraged if you lose. Summarize which link in the competition went wrong, try not to make the same mistake next time, and develop the excellent psychological quality of being brave to face the competition and taking the responsibility for failure.

5. Professional Training Objectives

This major cultivates and grasps the relevant knowledge and professional skills of industrial robots, bases itself on the Guangzhou Economic Development Zone and the Science City, faces the Pan-Pearl River Delta Economic Circle, cultivates the comprehensive development of morality, intelligence, physique and beauty, has the ability to develop, manufacture, install, debug, maintain and repair industrial robots, meets the needs of processing, production, application, construction and service, and has strong practical ability and working ability Advanced technical talents with innovative ability.

In order to cultivate highly skilled applied talents in the field of theory, knowledge, skills, and technology in this field, the researchers of this project combine the actual operation process of electronic information machinery, fully analyze the combination method of optimized system equipment, strengthen the design concept of system integration, integrate engineering systems, and improve the theoretical effect of information control. The researchers of this project take effective mechanical power development as the standard, clarify the standards for information and control functions, introduce microelectronics technology, effectively apply mechanical and electronic equipment to the system, and achieve production standardization.

5.1. Learning Achievement Standards for Professional Graduates

With reference to the American DQP (Degree Qualifications Profile) associate degree standard, determine the expected learning results of the four major learning areas (professional knowledge, extensive and integrated knowledge, intellectual skills, application and collaborative learning) of graduates' qualifications, so as to reflect the requirements on the professional ability, methodological ability, social ability, and integration and application ability of professional core field knowledge of graduates, namely graduation requirements. The "Program Outcome" (POC) of graduates of this major in various learning fields is described in Table 3.

To achieve the "professional expected learning outcome" (POC) of this major, students need to take a series of courses of this major, and complete the corresponding "subject outcome" (SOC) through the study of each course, in order to support and achieve the "professional expected learning outcome" (POC), so as to meet the requirements of this major for graduates.

The distribution of credit value of compulsory courses in five major learning areas of industrial robot technology is shown in Figure 2, and the distribution of credit value of compulsory courses in the "five major learning areas" of industrial robot specialty is shown in Table 4.

Table 3: POC and required knowledge and skills

Corresponding POC			Required knowledge and skills
Areas of expertise POC1	Professional knowledge and ability	POC 1.1.1	Describe the core theory and practice of industrial robot human-machine composition mechanism, electrical principle, workstation control principle and other related terms in the professional field of industrial robot, and provide at least one case related to the professional field
		POC 1.2.1	Be able to use the drawing technology, measuring technology, CAD/CAM software, industrial robot simulation software and other related technologies and methods learned to solve industrial robot product design, electrical circuit design and electrical control, and analyze products; Be able to install and debug the robot independently and repair simple faults
		POC 1.3.1	Basically make products, models, data, displays or performances in the professional field of industrial robot technology without error
Broad and integrated knowledge areasPOC2	Broad and integrated knowledge and skills	POC 2.1.1	Describe the existing knowledge and skills in the field of industrial robots: how to move forward, verify and correct, such as motor drive and sensor technology
		POC 2.2.1	Describe a key controversial issue (such as the advantages and disadvantages of servo control and hydraulic pneumatic control industrial robots) in the field of electromechanical and industrial robots learned, explain the significance of the controversial issue, and apply the concepts in this field to elaborate their own views on the controversial issue
		POC 2.3.1	Apply professional knowledge and technology to analyze practical or creative tasks, such as design scheme evaluation and background information collection
		POC 2.4.1	From the issues of science, art, society, human service, economy or science and technology (such as the impact of industrial robots on human life), use the knowledge of at least two fields to describe how to define, define and explain the significance of the selected issues to society, and make comments on it
Intellectual skill fieldPOC3	explore	POC 3.1.1	Propose and define a problem in the professional field, and be able to clarify various viewpoints, concepts, theories and solutions related to the problem
	Information utilization	POC 3.2.1	When implementing a design (such as the handling scene design of industrial robots), it can identify, classify and evaluate various resources, and apply the obtained information to the design scheme to complete the design
	Cultural understanding	POC 3.3.1	Describe the knowledge of different cultural perspectives and understand their impact on prominent issues in politics, society, art and international relations
		POC 3.3.2	Describe, explain and evaluate your own views on culture, society, politics, art or international relations, and compare them with other views
	ethic	POC 3.4.1	Describe the ethical and moral issues in prominent political, economic, medical, technical or artistic issues, and explain how these ethical and moral principles affect decisions on these issues
	Quantitative expression	POC 3.5.1	Use quantitative information (i.e. numbers and symbols) to accurately interpret relevant political, economic, health or technical issues
		POC 3.5.2	Create and interpret charts and other visual representations of trends, correlations, or changes in state
	communication skills	POC 3.6.1	After communicating with general and specific objects, write convincing, fluent and basically error-free articles
		POC 3.6.2	Effective verbal communication with the general public or a specific object in formal occasions
		POC 3.6.3	Negotiate the action plan of a specific work task, and summarize and communicate the negotiation results in writing or orally
		POC3.6.4	Use a foreign language for daily basic communication, and translate a simple article in the professional field of study
	innovative thinking	POC3.7.1	Analyze or elaborate the innovation, entrepreneurial characteristics and key elements involved in a practical case of innovation and entrepreneurship, and give your own judgment
		POC 3.7.2	Use the professional knowledge and skills to raise questions or problems, or put forward a new idea and method for practical activities in social, economic, technical, cultural and other fields
Application and collaborative learningPOC4	Application and collaborative learning ability	POC 4.1.1	Report at least one case in writing: explain how you applied the learned academic knowledge and technical skills to "practical challenges"; and provide evidence or cases to prove that you learned new knowledge or other gains in the application process
		POC 4.2.1	Share or teach students at least one important concept or method they learned outside the classroom
		POC 4.3.1	Independently or in collaboration with others, accurately locate a practical problem beyond what is learned in class, collect relevant clues and information, organize and analyze it, and propose various solutions
		POC 4.4.1	Participate in an innovative and entrepreneurial activity or project, show or explain its practical results, and make a written summary of its process (at least highlight the individual's perception of innovation and entrepreneurship and innovation and entrepreneurship management in this experience, and then clarify its application prospects or value)

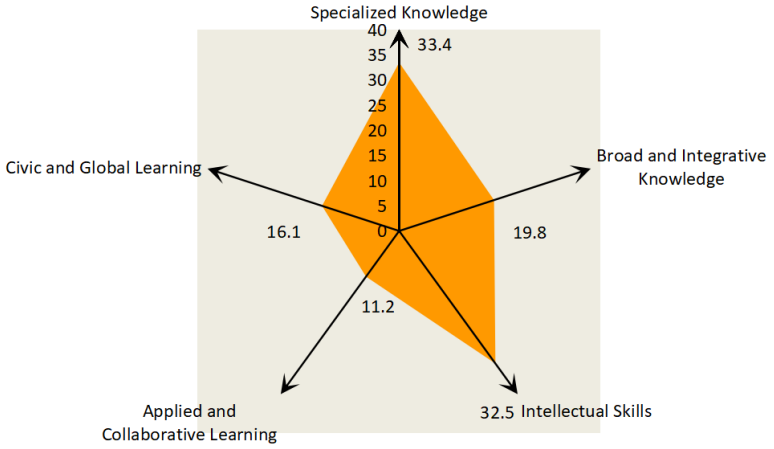

Figure 2: Distribution of credit value of compulsory courses in five major learning areas of industrial robot technology

Table 4: Credit distribution of compulsory courses in five major learning areas

Credit value of learning field		Credit value
1	Specialized Knowledge-POC1	33.4
2	Broad and Integrative Knowledge-POC2	19.8
3	Intellectual Skills-POC3	32.5
4	Applied and Collaborative Learning-POC4	11.2
5	Civic and Global Learning-POC5	16.1
Total credits		113

5.2. Improve the Assessment System and Follow up the Assessment Standards

Teaching evaluation and assessment is an important link in the teaching process. The scientific teaching evaluation system can accurately reflect the students' mastery of knowledge points and professional skills. In the implementation of the curriculum reform, we get inspiration from the scoring indicators of the professional skills competition. We have a one-to-one correspondence for these related skills points of programming, operation and teaching points. In this way, the knowledge points of students' learning are very clear. At the same time, when evaluating teaching, we can use these points to assess the completion of students, and then overcome some difficulties we encounter in teaching. Focusing on whether they meet the national vocational standards and relevant skill specifications, scientific evaluation of the completion of students' projects with the assessment criteria of skill competitions will help students form excellent professional skills and good professional quality [1-3].

6. Research Summary

6.1. Research Conclusion

The skills competition in vocational colleges is conducive to promoting the reform and innovation of talent training mode, helping students expand space, promoting the improvement of teachers' self-ability, promoting the reform of school professional courses and promoting school-enterprise cooperation. Therefore, the skills competition in vocational colleges has an extremely important role in promoting and positive significance for talent cultivation in schools

[4-6].

The skills competition in vocational colleges has the following basic characteristics: large scale; The event is newly set, highlighting the integration with economic and social development; Great social influence and high degree of attention; There are many focuses in the industry and a wide range of talents; School-enterprise interaction and win-win cooperation.

6.2. Research Deficiencies

It is a very complex work to reform the professional courses through the skills competition in vocational colleges. The research on the reform of the professional courses through the skills competition in vocational colleges is relatively simple, and there are still many problems to be studied and discussed. For these deficiencies, the following summary is made:

(1) In the practice of the reform, it was found that students' enthusiasm for participating in the skills competition in vocational colleges was not high, so it was necessary to increase the incentive mechanism in the future[7,8].

(2) Although this paper puts forward some suggestions on the curriculum reform through the skills competition in vocational colleges, it still needs to wait for the test of time. A more perfect reform mechanism needs to be explored step by step in the future, and the talent training mechanism needs to be improved step by step [9].

7. Conclusion

In teaching, the skills competition in vocational colleges plays a positive guiding role in talent training. On the path of talent training research and practice, guiding students to participate in the competition can effectively improve students' innovation, application, practical operation and team cooperation ability. It is necessary to explore a new mode of talent cultivation through the positive interaction between the vocational college competition and teaching practice.

In short, the vocational college skills competition has promoted the reform of the existing professional courses of the school, and also truly reflects the professional quality requirements of the society for vocational college students. Therefore, vocational colleges should integrate the assessment content, operation specifications and evaluation standards of the vocational skills competition into the whole process of talent training, so as to comprehensively improve the quality of talent training and better serve the regional economic and social development.

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