

Exploration and Practice of Mechatronics Professionals Training Reform Based on "Competitions and Post Combination, Competitions and Education Integration"

Qian Lv¹, Chunpeng Wang¹, Guiqin Li^{2,*} and Hongbo Liu³

¹School of Mechanical and Electrical Engineering, Binzhou Polytechnic, Binzhou, 256600, China

²School of Biological Engineering, Binzhou Polytechnic, Binzhou, 256600, China

³Dean's office, Binzhou Polytechnic, Binzhou, 256600, China

*Corresponding author. Email: 214741819@qq.com

ABSTRACT

Due to the poor connection between the current skill competition and regional posts, the ability to adapt to the post is weak. In view of the disconnection between skill competition and talent training process, it brings disadvantages such as "competition for competition", "top student preparation competition", "assault preparation competition", etc. Accordingly, the comprehensive mechanism of "competitions and post combination" and "competitions and education integration" was explored, and the reform and practice were carried out in the training of mechatronics professionals. Firstly, the skills competition was integrated into regional posts to build school-based competitions, and then integrated into professional skills courses and practice through the "four-dimensional competitions and post combination" mechanism. Subsequently, the skill competition such as "modern electrical control system installation and commissioning" and other skills competition and enterprise practical ability were integrated into the mechatronics professionals curriculum system. The "competitions and education integration" mechanism of "teaching preparation competition", "all staff preparation competition" and "whole process preparation competition" was realized. Finally, the national and provincial competition standards were layered into the curriculum standards, loose-leaf textbooks, teaching process and assessment, thus realizing the class-based skills competition. Practice has proved that mechanical and electrical students' ability to adapt to surrounding large-scale enterprises has been significantly improved, and the breadth and depth of students' benefit from the skills competition has been effectively improved. Also, the students' knowledge system is more comprehensive and solid, and their skills are more practical and stable. Therefore, the quality of mechatronics professionals talent training has been practically improved.

Keywords: *Competitions and post combination; Competitions and education integration; Mechatronics professionals; Skills competition*

1. INTRODUCTION

The annual national and provincial vocational college skills competition has effectively promoted the integration of industry and education, school-enterprise cooperation and the improvement of talent training quality [1]. However, there are also some problems in the implementation.

The national competition and provincial competition standards are not connected with regional economic posts, and the orientation of professional services is not accurate enough. Consequently, even if students win prizes in national and provincial competitions, their post-employment suitability is still weak. Therefore, the "competitions and post combination" mechanism of multi-dimensional regional posts in the skills competition was explored to improve the pertinence of talent training in

local vocational colleges and effectively improve the post adaptability of mechatronics professionals.

Simultaneously, the achievement has become an important index to measure the connotation construction achievements and school running level in vocational colleges with the development of technology competition. Vocational colleges unilaterally pursue competition results, with prominent problems such as "competition for competition", "assault preparation competition", "top students preparation competition", etc. The ability improvement of students is limited, and few students benefit from the competition. Therefore, this work explored the whole process of layering skill competition into talent training in mechatronics professionals, and truly realized "competitions and education integration". By "promoting learning through competition and teaching through competition", students' professional ability can be comprehensively improved.

2. FOUR-DIMENSIONAL POST AND COMPETITIONS COMBINATION AND SKILLS COMPETITION INTEGRATED INTO REGIONAL POSTS

The setting of skills competition is closely related to production practice and industrial hot spots, reflecting new technologies, new processes and new methods, and leading the cultivation of talents urgently needed in emerging industries. However, the economic industries in different regions have their own characteristics due to the different industrial structure and the imbalance of economic development in different regions. Students who simply possess knowledge, skills and accomplishment of national and provincial competitions are not suitable for employment at a high level and fast enough [2]. Consequently, it is urgent for professional events to connect with regional enterprise posts served by vocational colleges, thus further improving students' job adaptability on the basis of all-round development. Therefore, the project will study the connection between national and provincial skills competitions of vocational colleges and regional job economy. The following four dimensions are used to carry out the competitions and post combination docking, as shown in Fig. 1.

- 1) The competition contents of provincial and national competitions are connected with the work contents of posts and post groups.
- 2) The assessment standards of provincial and national competitions are connected with the job requirements of posts and post groups.
- 3) The competition personnel of provincial and national competitions are connected with the staff of posts and post groups.
- 4) The competition environment of provincial and national competitions is connected with the work environment of posts.
- 5) Therefore, the work contents and work requirements of their job groups such as electrical maintenance post and equipment installation and adjustment post were investigated combined with large-scale enterprises such as oil salt chemical industry, which are the pillar industries in the Yellow River delta. They are deeply connected with the competition contents and assessment standards of modern electrical and mechatronics technology, study the school-based skills competition, and build a regional and school-based college competition. The college will hold school-based skills competition once or twice every semester, and integrate school-based competitions into the "skills competition series courses" of the major. In class training, post rotation training, post setting training and other comprehensive post training were carried out to train post suitable talents for regional posts.

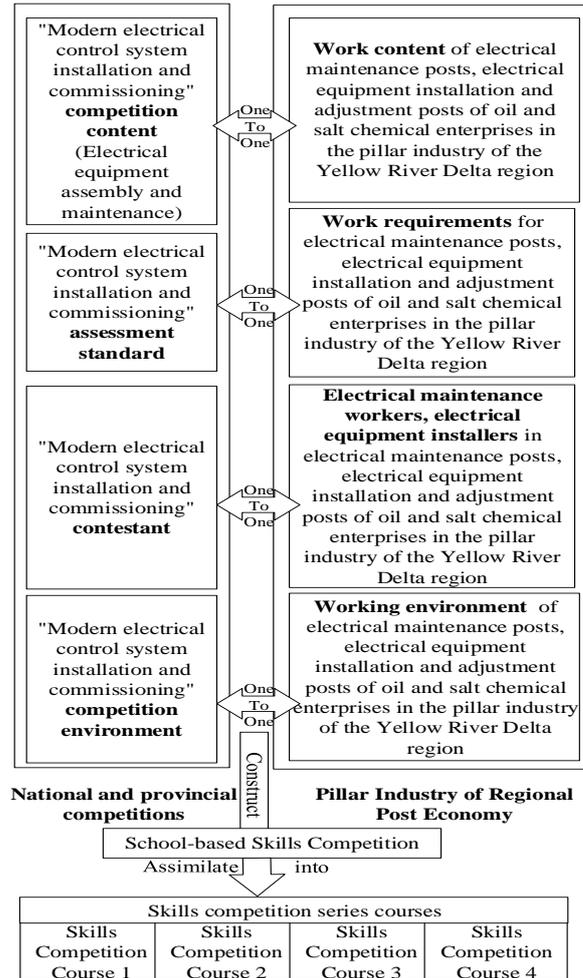


Figure 1. Four-dimensions docking and school-based skills competition

(Taking modern electrical control system installation and commissioning as an example)

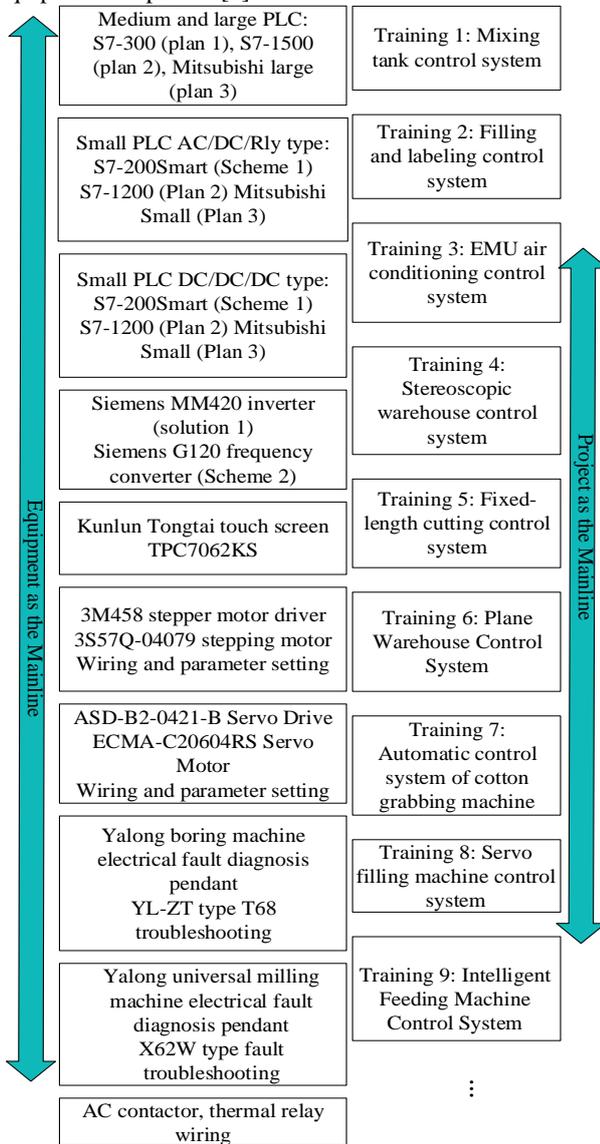
3. VOCATIONAL ABILITY STANDARD AND SKILLS COMPETITION INTEGRATED INTO CURRICULUM SYSTEM

In line with the guiding ideology of professional ability, we carry out preparatory training for all students in our post-based skill competition.

The traditional competition preparation training is "competition for competition" or "assault preparation competition". The ability of students is narrow and there are various problems. Taking the competition training of "modern electrical control system installation and commissioning" as an example, the detailed process of integrating skills competition into the curriculum system was analyzed.

In the national and provincial preparation competitions of "modern electrical control system installation and

commissioning", the training was initially carried out in the way of "equipment main line", as shown in Fig. 2 (a). For the hardware equipment used in the competition, the students were taught and trained in turn from S7-300/S7-200SmartPLC, MM420 frequency converter and Kunlun Tongtai touch screen TPC7062KS to 3M458 stepper motor driver and stepper motor. Because this training is too rigid on equipment and the knowledge and skills mastered are one-sided, it lacks comprehensive Application among equipment, training in solving practical cases, and the ability of comprehending and understanding when equipment is updated [3].



(a) "Equipment main line" (b) "Project main line"

Figure 2. Conventional preparation scheme

At the same time, the conventional "project main line" training method relatively focuses on the comprehensive Application of various equipment and cases, as shown in Fig. 2 (b). Based on the existing sample question bank, the training was carried out from "mixing tank control system"

to "intelligent feeding control system" in order from shallow to deep. However, the content of this training method is still narrow. Students only know the items in the sample questions, and their basic knowledge is not solid, and their skills are not solid. In the face of new questions in the on-site skills competition, students often have poor adaptability, let alone qualified for diversified practical employment positions.

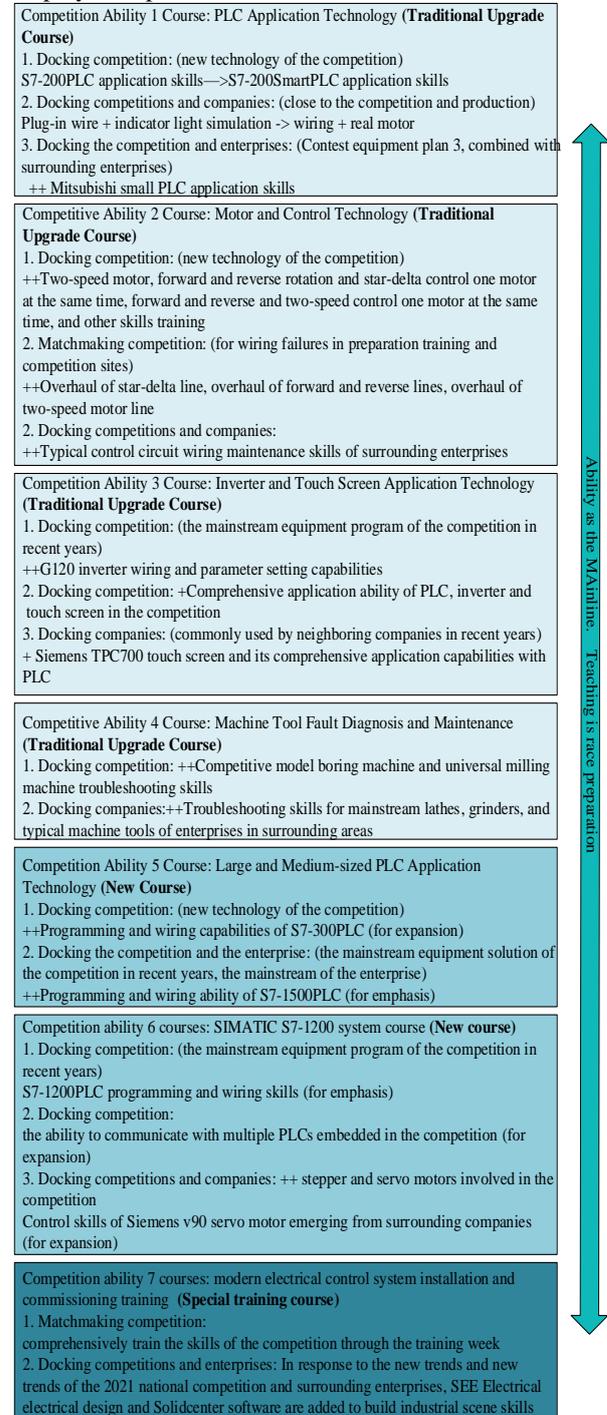


Figure 3. "Ability main line" improved preparation scheme

This study focused on improving the vocational ability level of mechatronics students and reforming the traditional training mode of "equipment main line" or "project main line". In line with the starting point of "ability main line", the preparation mode of "normalizing competition, teaching preparation competition" was explored and implemented. As shown in Fig. 3, the knowledge and skill points involved in the competition procedures of the skill competition was fully analyzed. The competition ability was integrated into the curriculum system through measures such as "conventional curriculum upgrade competition content", "emerging curriculum follow the competition direction", "specialized curriculum develop skills for the competition", "software and hardware measures guarantee the competition implementation", etc.

3.1. Conventional curriculum upgrade competition content

Aiming at the S7-200SmartPLC programming and application ability in the competition, the course of "PLC application technology" was upgraded to replace the original S7-200PLC teaching content for S7-200Smart series. At the same time, the original teaching mode of "plug-in + PLC control indicator simulation application" was reformed to "wiring + PLC control motor real application", thus being closer to the actual production and competition scene.

Focusing on the difficulties related to motor wiring ability in the competition, the course of "motor and control technology" was upgraded. The course added the training of expanding skills in the competition, such as the wiring of two speed motor, forward and reverse rotation and star triangle controlling the wiring of one motor at the same time, forward and reverse rotation and two speed controlling the wiring of one motor at the same time. In view of the wiring faults in the preparation training and competition site, the ability training of star delta control wiring maintenance, forward and reverse control wiring maintenance and two speed motor wiring maintenance were added.

For the application ability of G120 frequency converter required by the competition, relevant ability modules were added in the course of "frequency converter and touch screen application technology", and integrated application ability training of PLC, frequency converter and touch screen involved in the competition. Combined with Siemens series touch screen and other equipment newly developed by surrounding enterprises in recent years, the expansion training of TPC700 touch screen and PLC comprehensive application ability was embedded in the course of "frequency converter and touch screen application technology".

3.2. Emerging curriculum follow the competition direction

For the S7-300PLC programming and wiring ability in the competition, new courses such as large and medium-sized PLC application technology in mechatronics professionals for training were introduced. Recently, the PLC mainstream products of surrounding enterprises are gradually upgraded to S7-1200 and S7-1500 series, which is another more intelligent and convenient equipment scheme in this competition. Therefore, the new content of S7-1500PLC is added as the focus of "large and medium-sized PLC application technology", and the new course "S7-1200PLC system course" is added. In the teaching, the contents of multiple PLC communication and stepping servo motor control involved in the competition were introduced, and the control ability of Siemens V90 servo motor emerging from surrounding enterprises was added as an expansion. Students have more systematic knowledge, more comprehensive skills, and stronger job suitability and cutting-edge ability.

3.3. Specialized curriculum develop skills for the competition

Besides, the competition course "modern electrical control system installation and commissioning training" was specially introduced, which focused on training various comprehensive skills and literacy of the competition through the training week. At the same time, it analyzed the new trends of the 2021 national competition and surrounding enterprises, and added quality training such as SEE Electrical electrical design ability and Solidcenter industrial scene construction ability in the course.

3.4. Software and hardware measures guarantee the competition implementation

In order to ensure the smooth implementation of the skills competition into the curriculum system, a series of software and hardware measures have been taken to improve the practical teaching conditions and the level of teachers.

According to the competition standards, the competition platform was built, and the training rooms of "modern electrical control system installation and commissioning", "machine vision training room" and "automatic production line installation and commissioning training room" shared by competition and teaching were newly built. More than 40 sets of supporting Siemens series equipment were introduced, and a new Siemens advanced automation technology center was built. The center includes "S7-1200PLC_touch screen_frequency converter" basic training platform, "S7-1500PLC_touch screen_frequency converter_servo conveyor_stepping manipulator_process control" high-level training platform, discrete industry automation control system, chemical process control

system, intelligent manufacturing small industrial 4.0 system, industrial network control system, motion control system, etc. The center is authorized by Siemens to carry out Siemens engineer certification for S7-1200 PLC and S71500PLC.

The college and secondary colleges have formulated relevant policies to improve teachers' ability, such as encouraging teachers to actively participate in provincial and national training in winter and summer vacation. More than 30 teachers have been sent to participate in Siemens SCE basic course and S7-1500 comprehensive course training, among which 5 lecturers have been certified by Siemens and can carry out engineer certification for social personnel and students. Relevant teacher training courses organized by enterprises on the competition platform are encouraged to participate, and certificate training courses such as "metallurgical mechanical and electrical equipment spot inspection 1+ X" held by industry associations are encouraged to actively participate. Every semester, 20% of teachers are selected to take temporary posts in enterprises to exercise and study cutting-edge post technical skills, and experts from brother colleges and enterprises are invited to come to the school for exchange and guidance.

Therefore, the curriculum system, training equipment and teachers are fully equipped to fully support the integration of competition and post new technology into daily teaching, thus truly realizing the "comprehensive integration of course competition post certificate".

In line with the leading idea of "ability based", the ability of "modern electrical control system installation and commissioning" and other skills competition and enterprise practice are integrated into the course system of mechatronics professionals to achieve the "competitions and education integration" mechanism of "teaching preparation competition", "all staff preparation competition" and "whole process preparation competition". Through accumulated learning and training, more mechatronics professionals students not only benefit, but also their knowledge system is more comprehensive and solid, and their skill level is more stable. The introduction of new technology, new equipment and new teaching methods also urges students not to stick to the inherent traditional equipment, but to respond to the actual employment positions at the forefront and provide enterprises with more excellent technical skills.

4. STANDARDS ARE LAYERED EMBEDDED AND SKILLS COMPETITION IS INTEGRATED INTO THE TEACHING PROCESS

After the skills competition is integrated into the curriculum system, how to implement it in the classroom, and how to embed the standards of national and provincial competition into the whole process of mechatronics professionals talent training? Based on the competition rules and scoring standards of mechatronics "modern electrical system installation and commissioning",

"mechatronics" and other relevant national and provincial competitions, it is proposed to fully embed the national and provincial competition standards into the curriculum standards, loose leaf textbooks, teaching process and assessment evaluation. It fully realizes the classroom-based model of skills competition, which is "the standard of each course embedded in the competition" and "teaching in class is competition". Therefore, all students can learn and accumulate the professional basic knowledge necessary for the skill competition, hone and improve professional operation skills, and feel the environment and atmosphere of the skills competition. It has realized "promoting teaching, learning and reform through competition", and improved the performance of skills competition and the quality of talent training.

4.1. Incorporating curriculum standards and loose-leaf textbooks

In connection with modern electrical, mechatronics and other typical competition projects and typical jobs in surrounding enterprises, the standards of national competition, provincial competition and academy competition have been fragmented. It fully integrates the competition standards into the curriculum standards, comprehensively improves the curriculum design concept, accurately positions the curriculum, and embeds various links of the curriculum, mainly including:

- 1) Competition objectives are embedded in course objectives.
- 2) Competition content and technical specifications are embedded in the course content and requirements.
- 3) Competition scoring criteria are embedded in course assessment suggestions
- 4) Competition environment is embedded in the course implementation conditions

In view of the above aspects of the curriculum, we have cooperated with Siemens (China), Bohai Piston, Allied Daika and other enterprises to develop curriculum standards and loose leaf teaching materials, actively promote classroom reform, and build "dual" teaching materials for schools and enterprises. Combined with the Siemens product engineer certification standard, a new loose leaf and work manual teaching materials were jointly developed and constructed by using the German AHK certification teaching mode. Taking typical high-end aluminum processing projects of Bohai Piston and other cooperative enterprises as the carrier, curriculum standards and training standards as well as supporting information teaching resources were developed.

4.2. Integrating into teaching process and project evaluation

The competition mode and process of national and provincial standards were embedded in the whole teaching process [4]. It includes teaching objectives, teaching

contents, teaching methods and means, teaching resources and facilities, thus forming the normalization of skills competition in the teaching process and forming the teaching mode of "teaching is competition, and there are martial arts competitions in every hall". The main links are as follows.

4.2.1. Project preparation, teachers and training room administrators are the participants of the competition and the field arrangers

Teachers shall determine the teaching objectives, teaching contents, teaching links and teaching means of this class with reference to the competition objectives and contents, curriculum standards and competition post-based school-based teaching materials. Teachers and training room administrators shall uniformly arrange the teaching environment and venue according to the standards of facilities, consumables and tools required by the competition site.

4.2.2. Project implementation, teachers are inspectors and instructors

Task initiation: teachers refer to the competition process and take the actual competition project as the carrier to initiate the project requirements [5].

Scheme submission: students will discuss and submit the design scheme in groups of 2-3 according to the competition rules.

Scheme determination: the instructor comments, and the students work together to improve and determine the project scheme.

Skill practice: division and cooperation within the group, carry out skill practice and implement typical projects.

Comprehensive debugging: discuss and judge in groups, eliminate and find faults, and strive for the best results in limited time.

4.2.3. Project evaluation, teachers are chief judges and instructors

The scoring standards in the national and provincial standards are embedded in the classroom teaching assessment and evaluation in each section, including scoring indicators (competition, more standardized), evaluation contents (professional knowledge, post skills, professional quality and professional spirit, etc.), raters (school teachers, industry enterprise experts), evaluation objects (student completion, classroom teaching effect, etc.) [6]. The assessment and evaluation mechanism is more accurate and diversified. The main evaluation links are as follows.

All students leave the site: all students must finish the task and leave when the task ends.

The teacher organizes excellent students to form a referee group to discuss the scoring standards, and the members of the referee group divide the work.

Referee scoring: the team members to be evaluated enter the site, demonstrate the results according to the competition requirements, and evaluate the project completion gradually in strict accordance with the competition standards.

Success or failure summary and improvement: students in each group summarize and improve the completion of this time.

After class evaluation: the students upload the project results and summary evaluation to the cloud class, and the part-time teachers of industry enterprises will score and guide each group of tasks.

Practice has proved that the teaching process of "teaching is competition" is not only closer to the competition in the achievement of teaching content and teaching objectives, but also greatly stimulates the students' learning enthusiasm in the teaching effect. The task driven objectives are clearer, and the sense of time compactness is stronger. The sense of competition is significantly enhanced, and the classroom atmosphere is increasingly active, and the teamwork ability is effectively improved.

Accordingly, the "competitions and education integration" and "class-based skills competition" were truly realized by fully embedding the competition standards into the curriculum standards, loose leaf textbooks, teaching process and assessment and evaluation. Also, the "all staff preparation competition" and "whole process preparation competition" of education were realized, and the leading role of competition in professional construction and talent training was brought into full play.

5. CONCLUSION

Through the "four-dimensional competitions and post combination", the competition content and standards were integrated with the work content and requirements of the posts in the surrounding areas, thus constructing regional and school-based school competitions, realizing the match post integration, and greatly improving the ability of students to adapt to the post. Based on professional ability, the competition ability was integrated into the relevant curriculum system through strategies such as "conventional curriculum upgrade competition content", "emerging curriculum follow the competition direction", "specialized curriculum develop skills for the competition", "software and hardware measures guarantee the competition implementation", etc. Through the "standards are layered embedded", the national and provincial competition standards were fully embedded in the curriculum standards, loose leaf textbooks, teaching process and assessment evaluation, thereby realizing the classroom-based model of skills competition, which was "the standard of each course embedded in the competition" and "teaching in class is competition".

Through the implementation of multi-channel and all-round "competitions and post combination" and

"competitions and education integration" in mechatronics professionals, the school-based and classroom-based skills competition was realized. Practice has proved that mechanical and electrical students' ability to adapt to surrounding large-scale enterprises has been significantly improved, and the breadth and depth of students' benefit from the skills competition has been effectively improved. Also, the students' knowledge system is more comprehensive and solid, and their skills are more practical and stable. Therefore, the quality of mechatronics professionals talent training has been greatly improved.

ACKNOWLEDGMENT

This work was supported by Shandong vocational education and teaching reform research project in 2019 - the normal scheme design and implementation of "standard embedding, post docking, ability based" in vocational college skills competition (No. 2019248).

REFERENCES

- [1] Ma Z F. On the Role of Vocational Education Skill Competition in Promoting Teaching Reform [J]. *Modern Vocational Education*, 2019 (15).
- [2] Wang X. Analysis on Teaching Reform in Higher Vocational Colleges under the Background of Professional Skills Competition [J]. *Journal of Higher Education*, 2016 (11): 140-141.
- [3] Zhang G Y. Building a New Curriculum Reform Model of "Construction Engineering Surveying" Based on the Mapping Skills Competition in Higher Vocational Colleges [J]. *Science and Education Guide (Late)*, 2015 (10x): 41-42.
- [4] Huang Y L, Li M, et al. On the Teaching Mode of "Promoting Learning and Teaching through Competition, and Integrating Competition and Teaching" [J]. *Theoretical Research and Practice of Innovation and Entrepreneurship*, 2019, (4): 111-112.
- [5] Tao W. Exploration and Practice of "Promoting Teaching and Education through Competition" for Mechatronics Professionals [J]. *Education and Teaching Forum*, 2020 (41): 345-346.
- [6] Wang D. Thoughts on the Application of "Promoting Teaching and Learning through Competition" - Taking the Mobile Communication Specialty of Higher Vocational Education as an Example [J]. *Journal of Liaoning Higher Vocational Education*, 2020, 12 (22): 38-42.