Research on Practice of Electrical Control Simulation System in Motor and Electrical Control Technology Course Teaching in Higher Vocational Education

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Abstract: In the fierce competition environment, students' practical ability is more important. In order to adapt to the social development, constantly promote the curriculum reform of higher vocational colleges, enhance the professional practicality of electrical control technology course, enable students to master the relevant technology and improve the teaching quality, considering the actual situation of the school, the practical course of electrical control simulation system is proposed. The control group and the experimental group are set for teaching comparative analysis. While learning theoretical knowledge, students can practice through the simulation experiment system to further improve their practical ability. The results show that adding electrical control simulation system to the teaching of motor and electrical control technology course in higher vocational colleges can greatly improve students' practical ability, and give full play to students' subjective initiative, so that they can actively learn. Therefore, the application of electrical control simulation system in the teaching of motor and electrical control technology course in higher vocational colleges is of great significance for promoting teaching reform and improving students' practical ability.

1. Introduction
With the continuous socioeconomic development, social enterprises have an increasing demand for talents, especially for skilled talents, and the talent demand becomes more diversified with the unceasing technological progress. As new technologies are constantly promoted, the manufacturing industry has been transited from “mechanical electrification” into “mechatronics”, and thus enterprises have proposed higher requirements for employees’ practical skills and practical work abilities. Therefore, the cultivation work of highly skilled talents should be strengthened in higher vocational colleges, and the whole process from course content to teaching process should be improved in order to cultivate high-tech talents more conforming to the development of the times and the demands of social enterprises [1].

Responding to the national vocational education reform that deepens the “integration of production and education” and its development, the course reform in higher vocational colleges aims to improve the practical courses through trials and errors, and further improve students’ practical abilities. When it comes to talent cultivation of mechanical & electrical majors, most of the higher vocational colleges in China lay particular emphasis on theoretical contents while neglecting practice, and they will evaluate the teaching quality and result according to students’ theory test results in most cases. Meanwhile, the traditional educational theory courses are mostly set in higher vocational colleges, while the practice teaching is overlooked. As an important place of cultivating technical talents, higher vocational colleges require their students to engage in CNC programming, CNC equipment operation and troubleshooting with strong operating performance after graduation in order to improve their practical abilities. In the
practical link, the teaching model based on field material object demonstration is of high cost, and this is the reason why many higher vocational colleges are not willing to input high cost to carry out this work [2]. However, the simulation technology has become an important practical tool in many fields thanks to the constant development of information technology. By reproducing the essential process occurring in actual system, the simulation technology completes the model simulation via input and output so that users can get deep understanding of the theoretical contents behind the model through the simulation system. For the specialty of electrical automation, the electrical control simulation system is very suitable for students in higher vocational colleges to practice and exercise, as it deepens students’ understanding of theories in practice.

To sum up, in consideration that the electrical control circuit simulation experiment system can help students to complete the practical operation, and deepen theoretical understanding in practice, and in view of the demand of the electrical automation specialty for practice in higher vocational colleges, the electrical simulation control system is applied to the course teaching of the electrical control technology. The effectiveness of the teaching model is verified through an experimental comparison and analysis, so as to provide more methods for cultivating professional high-tech talents.

2. Literature Review
In order to improve students’ practical abilities, theory teaching and practice teaching are integrated in higher vocational colleges. This topic has become an important basis for many scholars in the field of education to promote the teaching reform. Gao J (2018) pointed out that besides a certain theoretical knowledge, students should be self-equipped with practical abilities to better adapt to the social development demand, and propose reform measures for the practice teaching model of the electronic automation specialty in higher vocational colleges, which would improve the practice teaching effect [3]. Liu H L (2019) proposed that the current innovation & entrepreneurship education in higher vocational colleges should start from the course system reform. Taking the specialty of electrical automation technology for example, the scholar integrated the innovation & entrepreneurship education into the teaching work to improve the professional innovation work while solving the technology practice [4].

Lin Y (2019) stated that the simulation technology had become an advanced comprehensive technology, and when closely combined with the internet technology, the constructed systematic and scientific simulation model could effectively improve the teaching level in professional courses, and provide a reliable tool for realizing the teaching objectives of electrical control technology [5]. Liu X and Li X B (2019) applied the simulation experiment teaching model to the electrical control design, aiming to realize extension-type classroom theory teaching by virtue of virtual simulation experiment, realize resource sharing, strengthen the experiment teaching effect, and improve students’ innovation ability and practical ability [6].

In conclusion, many of the past researches have explored the course reform in higher vocational colleges and the application of simulation system in their specialized courses, but most of them have focused on talent training mode and qualitative researches, while few have tried to set control experiments for comparisons. Hence, the electrical control simulation system is applied to the course teaching of higher vocational motor and electrical control technology in this study. The effectiveness of this model is verified through a control experiment to facilitate the development of teaching reform.

3. Experiment Settings

3.1 Electrical control
In higher vocational colleges, as a core professional course in specialties like robot, machinery and mechatronics, the electrical control technology requires students not only to master the electrical control technology but also to cultivate good manual practical ability, and on this basis, the students can implement the control technology of production process automation by taking gears or systems powered by various perpetual motion machines as the objects. Nowadays the electrical control technology has been extensively applied in many fields, and many colleges are continuously exploring the application
of simulation technology in the electrical control technology in order to improve the teaching effect. As the electrical control technology is an experimental course, the theoretical knowledge can be transformed into practical contents only through practical operations.

3.2 Experimental simulation
The conceived system is tested using a system model, and then used to replace the actual system, because high cost will be caused once an error appears in the direct test on the actual system, and what’s worse, the direct verification may also threaten lives under some specific conditions. The practical operation through electrically controlled simulation experiment system can not only enable students to practice based on understanding of theoretical knowledge but also can mitigate the negative effect to the minimum level and practice students’ practical operating abilities.

3.3 Applied research
In this study, 80 sophomores and 5 teachers were selected from Chongqing Vocational College of Transportation, where the students were averagely divided into two groups: experimental group and control group. The students in the experimental group were required to practice the electrical control simulation experiment system based on the original courses, while those in the control group studied by following the original course settings. The learning level and background of students in the experimental group were equivalent to those in the control group, so the differences induced by personal factors could be excluded.

Pre-class investigation: We plan to investigate the teaching status of the electrical control technology course in Chongqing Vocational College of Transportation, and get to know teachers’ opinions over the course teaching, e.g. whether the school’s teaching resources can be effectively integrated in the teaching process, and whether the ratio of practice course hours to theoretical knowledge teaching hours is suitable. Meanwhile, attempts are made to collect teachers’ suggestions on the course reform and practical operations by adding the electrical control simulation system in the technology course teaching. The satisfaction degree of students with the present theory + practical operation pattern as well as their feelings and suggestions in the learning process are comprehended.

Experimental group: Under the original “theory + practical operation” course setting, some theoretical courses are compressed, while the practical operation course of the electrical control simulation system is added. Moreover, the theoretical knowledge is further explained in the simulation class.

Control group: The traditional “theory + practical operation” model is adopted.

After-class assessment: The theory test and practical operation test are combined, where the performance in the written theory test serves as the secondary assessment part, and the performance in the practical operation project is the primary assessment part. The importance is attached to the cultivation and improvement of students’ skills and quality, with the comprehensive assessment taken as the principal part and outcome assessment as the complementary part.

Model evaluation: The classroom teaching evaluation scale is used upon the ending of the semester for the students in the experimental group to evaluate the improved teaching model, and their performances will be combined to further judge the effectiveness of the proposed teaching model.

4. Experimental Result

4.1 Satisfaction survey
During the course satisfaction survey on the teachers and students in Chongqing Vocational College of Transportation setting up the electrical control technology course, a total of 120 questionnaires were given out, and 110 valid questionnaires were finally collected. Among the 110 people (5 teachers and 105 students), 10% of the students were very satisfied with the existing classroom teaching model, 46.4% showed general satisfaction degree, and even 20 students were dissatisfied with the current teaching model. Restricted by related equipment and conditions in the college, the students could accept limited
job training.

The current educational pattern pays more attention to cultivating students’ basic knowledge and operating skills, while the improvement of comprehensive ability mainly relies upon off-campus internship. However, the theoretical knowledge contained in the electrical control technology course is abstract with high requirements for manual practical operating abilities, so many students hope that the college can introduce a new teaching model and increase the opportunity of practical operation, thus consolidating their theoretical knowledge, deepening their understanding of knowledge and improving their comprehensive abilities through the practical operations.

In the meantime, the course demand and suggestions are collected from the teachers and students for an analysis as seen in Table 1:

| Question | Content                                                                                                                                                                                                 | Number of people |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| 1. How is the currently adopted course teaching method? | A. Being ordinary, this method fails to motivate students’ learning interest, so the proportion of the practical operation course should be elevated | 4                |
|          | B. It can stimulate students’ interest, and the ratio of theory teaching to practical operation is suitable                                      | 1                |
| 2. Do you think that the current teaching model can improve the course teaching effect? | A. Theory first, practice second                                                                                                               | 1                |
|          | B. Practice first, theory second                                                                                                            | 0                |
|          | C. Theory and practice are integrated by combining their contents                                                                            | 1                |
|          | D. Off-campus practice or new technical support is added                                                                                    | 3                |

From the teachers’ scoring results, they show ordinary satisfaction with the present teaching model of this course, and most of the teachers hope to improve students’ practical operating abilities by adding off-campus practice or providing new technical support.

The results in Table 2 are obtained through a summary and analysis of the students’ suggestions:

| Question | Content                                                                                                                                                                                                 | Number of people |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| 1. How is the currently adopted course teaching method? | A. Being ordinary, this method fails to motivate students’ learning interest, so the proportion of the practical operation course should be elevated | 86               |
|          | B. It can stimulate students’ interest, and the ratio of theory teaching to practical operation is suitable                                      | 19               |
| 2. Do you think that the current teaching model can improve the course teaching effect? | A. Theory first, practice second                                                                                                               | 78               |
|          | B. Practice first, theory second                                                                                                            | 3                |
|          | C. Theory and practice are integrated by combining their contents                                                                            | 8                |
|          | D. Off-campus practice or new technical support is added                                                                                    | 16               |

According to the students’ suggestions, most of the students think the current teaching method ordinary, and only 19 of them believe it suitable. Meanwhile, 78 students deem that the theory should come first, and practice second during the teaching process of the electrical control simulation system, so as to improve their practical operating abilities. 16 students consider that the practical operation can be supported by off-campus practice or new technology on the existing teaching basis.

To sum up, most of the students and teachers express their suggestions over the existing teaching
process, and hope that importance can be attached to their practical operating ability, and more practical opportunities can be provided to them in the course arrangement. The professional courses and the service theory of production technology should be integrated to improve students’ professional skills, and effectively enhance their comprehensive vocational abilities, and thus they can match with the social development and the talent demands of enterprises.

4.2 Control experimental analysis
Through one-semester learning, the assessment was carried out at the end of the term by means of "written test + practical operation", and the performance results of the two groups of students were obtained as seen in Table 3:

| Group               | Mean value of written test result | Mean value of practical operation result |
|---------------------|----------------------------------|----------------------------------------|
| Experimental group  | 93.3                             | 89.6                                   |
| Control group       | 86.1                             | 77.8                                   |

It can be observed from the above results that both the written test results and practical operation results of the students in the experimental group are different from those in the control group to a certain extent, possibly because the practical operation course of the electrical control simulation system is added based on the original “theory + practical operation” course in the experimental group. In the practical operation process, the students are enabled to deeply master the theoretical knowledge, and their practical operating abilities are strengthened.

After the course was completed, the evaluation results of the students in the experimental group were collected using a course evaluation scale (full score: 4), and then the evaluation results are presented in Table 4:

| Item                                | Evaluation criterion                  | Mean score | Mean total score |
|-------------------------------------|--------------------------------------|------------|-----------------|
| Theoretical knowledge               | The contents are explained clearly    | 8          | 7.67            |
|                                     | Key technologies are mastered         | 7          |                 |
|                                     | Theoretical knowledge is familiar to students | 8          |                 |
| Practical operation and simulation experiment | Theoretical knowledge is enhanced | 9          | 9.33            |
|                                     | The manual operation ability is strengthened | 10         |                 |
|                                     | Learning interest is further motivated | 9          |                 |

According to the statistical results of the students’ evaluation, the students speak highly of the opportunity added to practically operate the electrical control simulation system, and believe that this model can reinforce their theoretical knowledge and manual operation abilities, so as to motivate their learning interests and further improve their comprehensive vocational abilities.

In conclusion, the experimental course of the electrical control simulation system is added into the electrical control technology course teaching. This can not only deepen students’ understanding of related theoretical knowledge but also improve their practical operation performance, thus improving their comprehensive operating abilities. Meanwhile, based on the students’ feedbacks and evaluation results, the students in the experimental group are satisfied with the existing teaching model, which further verifies the feasibility and effectiveness of the proposed teaching model.
5. Conclusion
Above all, the students learning the electrical control technology course and the teachers were investigated, and then their current demands were analyzed and understood through their suggestions. On this basis, 80 students and 5 teachers were selected as the research objects and divided into the experimental group and control group. Through a comparative analysis, the electrical control simulation system was applied to the course teaching of higher vocational motor and electrical control technology, and furthermore, the feasibility and effectiveness of the electrical control simulation system when applied to the motor and electrical control technology course were verified. However, the application effects under different proportions of practical operation hours were not analyzed in the research process. Hence, the influence of the ratio of theory course hours to practice course hours will be further analyzed in the follow-up research. Promoting the higher vocational course reform work according to social and enterprise development demands is conducive to cultivating high-quality technical talents with excellent comprehensive quality, providing more reform ideas for talent education work in colleges, and realizing seamless connection with the society and enterprises.

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