Exploration on Virtual Simulation Experimental Teaching Model of Welding Specialty in Colleges and Universities

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Abstract: In the backgrounds of educational comprehensive informationization, combining the characteristics of welding specialty and the demand of talents in welding industry, this paper analysed the current situation of experimental teaching of welding specialty in colleges and universities and the advantages of virtual simulation experimental teaching, and discussed the construction of virtual simulation experimental teaching system for welding in colleges and universities from four aspects, which will promote the reform and innovation of welding experimental teaching in colleges and universities, improve the quality and level of experimental teaching, and provide a new mode and concept for high-level innovative compound talents training in welding specialty.

1. Introduction

As cloud computing, Internet +, big data, artificial intelligence, virtual reality/augmented reality/mixed reality and other emerging information technology have been widely applied, more and more information technology has been integrated into the teaching, which has become an important factor to subvert the traditional teaching mode and means [1]. On Feb.11th, 2018, the announcement issued by the General Office of the Ministry of Education "Key Points of Education Informatization and Network Security Work in 2018" pointed out that it is necessary to promote the in-depth application of new technologies such as big data, virtual reality and artificial intelligence in education and teaching [2]. It can be seen that education informationization has begun to receive universal attention and started to develop towards teaching informationization in an all-round way. In this context, more and more universities have strengthened the development of virtual simulation experimental teaching in many courses [3-5], which greatly promoted the construction of experimental teaching information, and promoted the reform and innovation of experimental teaching in colleges and universities

Welding is one of the most important key technologies in the field of industrial manufacturing. It is widely used in aerospace, high-speed railway, automobile manufacturing, machinery manufacturing, ship manufacturing, powder metallurgy, microelectronics, sensors and other industrial fields. The full development of welding technology plays a key role in China's transition from a big manufacturing country to a powerful one. The development of welding technology cannot be separated from welding professional and technical talents [6]. Compound welding talents with solid professional basic theory knowledge and practical operation skills are the driving force and the inevitable demand of the development of our innovative country.

2. Teaching Characteristics and Current Situation of Welding Course

Welding is a comprehensive subject, involving the interdisciplinary cross-integration of materials, machinery, mechanics, electrotechnics, etc. what is more, it is a practical subject. Welding

professionals must master various operation skills of different welding processes (fusion welding, pressure welding and brazing) and operation methods of different welding equipment. At present, welding specialty teaching in most universities is a process of theory + experiment, which is mainly taught by teachers. However, with the emergence of new welding technologies, new welding methods, new technology, new equipment and new materials, the existing equipments, teaching contents and modes in universities cannot meet the training needs of welding professionals under the new situation [7-10]. The main problems are as follows:

2.1 Single and Lag of the Teaching Content and Mode in Experimental Course.

At present, teachers in university still remain the traditional thinking about the experimental teaching in welding specialty, that is, teachers give lectures and demonstrations, while students accept them passively. This kind of cramming teaching method is disadvantageous to students' enthusiasm and initiative. In addition, in the experiment, students are required to operate strictly according to the experimental instruction book, and students are not allowed to play freely, so that the experimental teaching does not meet the requirements of cultivating students'innovative ability.

2.2 Less Opportunities for Practical Training in Experimental Classes.

Practice is an important link for welding professionals to acquire professional skills. However, in most universities, the welding experimental class is short, the number of experimental equipment is insufficient, and students cannot get enough practice in class, so it is difficult to master the real welding technology. In addition, many welding equipments have certain dangers in the operation process (such as electric shock, welding spatter, arc radiation, etc.), which can only be carried out under the guidance of teachers. However, due to the large number of students and the limited number of experimental teachers, it is impossible to guide every student, so it is impossible to ensure that every student can get training opportunities.

2.3 Lack of Advanced Welding Experimental Equipment.

The experimental equipment is the basic guarantee of welding experimental teaching. With the development of welding technology, many advanced welding technology and equipment have been widely used in production practice, such as friction stir welding equipment, ultrasonic welding equipment, laser welding equipment, etc. However, due to the limited funds, most universities have not purchased these advanced welding equipments, so it is impossible to carry out corresponding experimental courses. This leads to the disconnection between the knowledge and skills learnt by students and the development of science and technology, and make it difficult for students to meet the needs of social applied talents.

2.4 Imperfect Evaluation System of Experimental Results.

At present, there are still some problems in the evaluation system of experimental results of welding specialty in colleges and universities. The existing evaluation system mainly includes two aspects: on-site operation ability and experimental report. The on-site operation ability evaluation is obtained by teachers through observing the actual operation performance in the experimental class, which requires sufficient resources about welding equipments, teachers and evaluation time. However, the lack of these conditions inevitably leads to the lack of objectivity in evaluation. Furthermore, some students do not attach enough importance to the experimental course, do not preview before class, do not attend class carefully and do not actively, resulting in higher repetition rate of experimental report content and data. Therefore, students cannot obtain real experimental skills and improve the comprehensive quality.

3. Characteristics and Advantages of Virtual Simulation Experimental Teaching

Virtual simulation experimental teaching relies on virtual reality, multimedia, human-computer interaction, database and network communication technology to build a highly simulated virtual experimental environment and experimental objects. Students carry out experiments in the virtual

environment to achieve the teaching effect required by the syllabus.

3.1 Enriching Teaching forms and Enhancing Learning Interest.

In virtual experiment, a large number of three-dimensional pictures, animations and videos are used to make the experiment more vivid. The attraction of the network is often more likable to students than the boring theoretical knowledge. It stimulates the interest in the experiment. In addition, in the process of virtual simulation experiment teaching, the experimental principle and process details which are difficult to observe in the laboratory experiments can be displayed (for example, in the fusion welding experiment, the flow process of liquid metal in the molten pool can be displayed by the virtual simulation experiment; in the resistance spot welding experiment, the process of the instantaneous heat generated, diffused and form the spot welded joint can be displayed by the virtual simulation experiment) which can enhance the sense of interaction, immersion and presence, improve the enthusiasm and initiative in learning, and at the same time, it cultivates the practical, mental and innovative thinking abilities for students.

3.2 Increasing More Training Chances to the student.

The virtual experiment can be carried out by one person and one machine independently, which can be repeated and revised repeatedly. As a result, it offers more training chance and ensures that the students master experimental methods and welding technology. Moreover, the virtual simulation experimental platform supports multi-terminal operation, such as PC, iPad, mobile phone, etc., so that students can learn freely at any time and anywhere. This not only improves the efficiency of practical teaching, but also helps students to acquire solid experimental skills.

3.3 Reducing the investment of the Experimental Materials and Equipment.

Instruments, materials and tools in virtual experiments can be automatically restored and used infinitely, which greatly saves experimental materials and reduces energy consumption. In addition, virtual experiment is not limited by site, time and number of times, which makes up for the visual effect without real equipment, and reduces the cost of purchasing large-scale equipments and building laboratories.

3.4 Perfecting Experimental Teaching Evaluation System.

The virtual simulation experiment system can realize the function of experiment monitoring, evaluation and feedback for the experimental process [10]. Virtual simulation experiment sets up preview assessment and experimental operation process assessment to evaluate students comprehensively. Preview assessment mainly includes: laboratory safety knowledge, theoretical review, experimental purpose, principle, content, steps, etc., to complete the relevant experimental preview work. After the preview, the preview examination will be carried out, so that the qualified students can enter the simulation experiment operation site to carry out the experiment, thus guiding and encouraging the students to complete the preparatory work before the experiment course independently. Examination of the experimental operation process mainly includes: experimental preview, sample clamping, equipment start-up, parameter setting, safety protection, sample processing, shutdown sequence, etc. The system records the experimental operation process. Combining the above two parts, the scores can be given for each operation step according to the experimental operation points, and also give the scores for each task.

4. Construction of Virtual Simulation Experimental Teaching System for Welding Specialty

In view of the characteristics and current situation of welding course and the advantages of virtual simulation experimental teaching, it is imperative to construct a virtual simulation experimental teaching system for welding.

4.1 Course System Construction.

Virtual simulation experimental teaching and laboratory teaching are both important parts of

experimental teaching, and they are complementary. Therefore, in the process of formulating undergraduate training programs and syllabus, we should build a reasonable course system according to the specific situation of welding course, form a complementary and complete experimental teaching system, and improve the quality and level of experimental teaching.

4.2 Experimental Projects Construction.

Virtual simulation experiment project is the core content of the virtual simulation experimental teaching system construction in Colleges and universities. The virtual simulation experiment project should embody the principle of "virtual reality combination, mutual complementarity and can be realistic do not be virtual". On the basis of scientific analysis of the connotation of welding course, teachers need to put forward the construction scheme of experiment projects, develop a series of high-quality virtual simulation experimental teaching projects, and improve the attractiveness and effectiveness of experimental teaching projects.

4.3 Experimental Teaching Project Operation and Sharing Platform Construction.

The running and sharing platform of virtual simulation experimental teaching project is the carrier of virtual simulation experiment project, and is also the basic condition to realize the open and sharing of virtual simulation experimental project. The first choice is to improve the functions (functions such as experiment guidance, experiment assessment, communication platform, registration and confidentiality, background management, compatibility and expansion, etc.) of the experimental operation platform to meet the needs of different levels and different types of students to access the virtual simulation experimental teaching project both inside and outside the school and in a wider scope. By integrating resources, a digital virtual simulation experimental teaching platform with compatibility, expansibility, advancement, efficiency and practicability is built to effectively improve the efficiency and quality of experimental teaching management.

4.4 Experimental Teaching Team Construction.

The research and development, operation and maintenance of virtual simulation experiment cannot be separated from the experimental teaching team composed of teachers and experimental technicians. Around the operation of virtual simulation experimental teaching project, the professional ability of teachers and experimental technicians should be improved by learning, training and other measures. It should build a virtual simulation experimental teaching team with noble ethics, advanced concepts, strong technical ability, rich practical experience and reasonable structure. At the same time, it should improve the mechanism of examination, reward and supervision of experimental teaching team, and encourage and support teachers to participate in the research and development of virtual simulation experimental teaching projects and teaching practice[11,12].

5. Summary

Virtual simulation experimental teaching mode is a new teaching mode under the condition of education informatization development trend. The application of virtual simulation experiment teaching mode in welding specialty in colleges and universities can make up for the shortcomings of traditional experiment teaching. Through the construction of welding course system, experimental project, network management platform and experimental teaching team, the virtual simulation experimental teaching system of welding is constructed to comprehensively improve the professional technical ability for students, so as to achieve the training goal of high-level innovative compound talents of welding specialty.

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